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Fast and audacious as all get-out! Is it worth the high price? PG. 78



MAXIMUM PC

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2014 TECH PREVIEW

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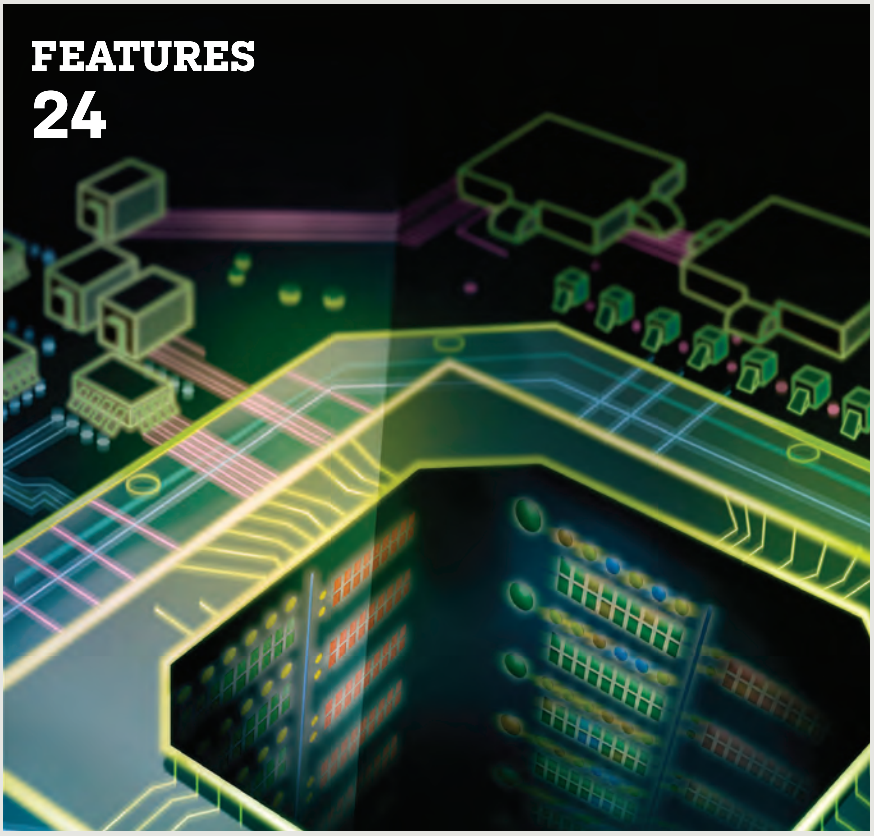
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Illustration by
Georg Zumbulev

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Gordon Mah Ung

THE END IS BRIGHT

EVERY FALL for the last, I dunno, 13 years, I've crawled Intel's Developer Forum looking for the latest in PC technology. From new chipsets to microarchitectural changes to chassis-cooling design recommendations, much of it is announced at IDF, given Intel's oversized footprint in the PC world.

This year, though, there was much backroom grumbling from enthusiasts and PC OEMs at the event. IDF was predictably laser-focused on mobile and even sub-mobile computing, as Intel made much ado about Bay Trail and a new CPU even smaller than Atom called Quark that's apparently intended to compete with embedded computing.

We saw a few sub-miniature machines such as Intel's new Haswell-based NUC and Gigabyte's really spiffy BRIX—which are arguably not exactly enthusiast desktop machines—but there wasn't much outside of mobile talk. Even the launch of the Intel's new enthusiast Ivy Bridge-E hardly rated a peep at IDF.

Predictably, media outlets pointed to IDF as another sign of the end being nigh for the PC—especially the desktop PC, you dinosaur you.

If I've just royally bummed you out, don't feel too bad. Despite the continued belief that the world is only about mobility, we found shoots of desktop life at IDF. Asus, Intel, and Corsair, for example, pulled a Magnificent Seven act and hired a crack team of overclockers to break five world records just for fun.

I also personally witnessed a desktop PC running a Haswell-E and DDR4. That pretty much proves that Haswell-E is imminent (well, if you wait another 12 months, that is.) I also saw new X79 motherboards and Thunderbolt 2–enabled Z87 boards on display.

In our own Tech Preview (page 24), Josh Norem details what we know of Nvidia and AMD's desktop GPU plans—parts that will never, ever fit into a tablet. In the same feature, I also lay out the case for and against buying Intel's new enthusiast Ivy Bridge-E CPU, and in our reviews we get a glimpse of what Dream Machine 2013 might have been had we had access to that CPU a few months in advance.

Besides the graphics war between AMD and Nvidia continuing unabated next year, we'll probably also see a "refreshed" Haswell desktop/mainstream chip (in addition to Haswell-E, of course).

By 2015, expect to see Intel's "Skylake," which will usher in a new era with DDR4 for mainstream users as well as PCIe 4.0 and SATA Express. AMD's CPU division, likewise, is still there too, and we'll hopefully see its Excavator-based APUs and CPUs by next year and beyond. Let's not even get into lower-cost 4K displays, insanely dense amounts of system RAM, and much faster SSDs. In other words: Don't fret—the future is actually bright, and really fast, too.



Gordon Mah Ung is Maximum PC's deputy editor, senior hardware expert, and all-around muckraker.

submit your questions to: comments@maximumpc.com

THE NEWS

Intel Demos SSD Overclocking

Touts possibility of offering K-series 'unlocked' SSDs in the future

THIS MONTH, Intel turned heads at several technology conferences by demonstrating solid-state disk overclocking, something that has never been possible before, due to the inability to access the controls that would allow it. At both the PAX Prime conference and at its own Intel Developer's Forum, Chipzilla trotted out a prototype SSD with custom software that allows a user to tweak both the clock speed of the SSD's onboard memory controller and the speed of the memory bus that transmits data between the controller and the NAND flash. Intel says it is considering offering the technology to consumers, but for now it's just testing the waters.

EXTREME TUNING, INDEED

In the demonstrations, Intel loaded up its Extreme Tuning Utility (XTU) software and used it to control a prototype enterprise drive. The demonstrator began by changing the speed at which the SSD's onboard controller was running, taking it from its stock 400MHz all the way up to 625MHz. Next, the demonstrator altered the frequency of the memory bus used by the NAND flash, going from 83MHz to 100MHz. Intel ran a few benchmarks to show the performance gains. Admittedly, gains were modest, with most scores improving by roughly 10–15 percent; some benchmarks responded better to overclocking than others. What was most impressive was the ease at which the gains were brought about—a simple flick of the switch, essentially—but we're skeptical that anyone in the "real world" would even notice such a difference in what is already an incredibly fast device. The average user would barely notice a boost in sequential read speeds from 450MB/s to 500MB/s, for example.

> “THE QUESTION IS WHETHER IT WILL SHORTEN AN SSD'S LFESPAN

RISKY BUSINESS

The bigger question here isn't whether overclocking will improve performance, as we know it will, but rather whether it will shorten an SSD's lifespan or compromise data integrity in any way. So far, Intel hasn't offered any specifics on what kind of impact it will have, but we know it will have some impact because, well, that's how overclocking works. Intel was also handing out surveys at PAX that asked people what they thought about SSD overclocking, and that included scary responses such as: "[I support] Unlimited Overclocking, the OS can always be re-installed," and, "I'd trade the life of the drive for more speed."

FOR INTEL ONLY

If Intel brings this product to market, it will be in the form of new K-series "unlocked" SSDs that are similar to its K-series CPUs. Reports indicate the capability will be accessible through the XTU software and will only work on Intel-branded CPUs. There's also a high probability that the settings will include bus-frequency adjustment, controller clock speed, and power-consumption levels, as well. As an example, you could possibly adjust the SSD's power settings like you do your display's, telling it to sip power if you're using a laptop, or guzzle as much juice as needed if you're on a desktop.

COLOR US UNCONVINCED

Though we appreciate Intel's initiative on this one, we have to say that the integrity of our data and the stability of our OS are much more precious to us than a hardly noticeable speed gain. We love overclocking, and we love SSDs, but in our opinion, we should just keep the two separate for now. **–Josh Norem**



If Intel brings this technology to market, it will only be offered on its own branded SSDs.



Tom Halfhill
Fast Forward

EVEN BIG IRON OBEYS SPEED LIMITS

IT'S RISKY TO deduce technology trends from exotic examples for which cost is no object. Otherwise, we might predict that all sailboats will someday be hydroplane catamarans with 12-story-tall carbon-fiber wingsails. But some cutting-edge technology does trickle down to the masses.

Consider IBM's new POWER8 server processor. Although it has "only" 12 CPU cores, they are probably the most powerful yet designed. Each core can issue up to eight instructions per cycle to 14 function units while running eight threads. To support them, POWER8 has more than 100MB of cache, including 96MB of IBM's embedded DRAM (eDRAM), which requires only one-third the space of conventional SRAM. Manufactured in IBM's 22nm process technology, POWER8 has more than 3 billion transistors, measures a whopping $650mm^2$, and consumes about 250W.

Of course, we can do without some of those specs. The massive die inflates manufacturing costs—no wonder IBM hasn't disclosed the price. And the heat dissipation would turn most PCs into a puddle of solder. But some other specs look more attractive.

Mainly, we need more threads. Almost 14 years since Intel introduced Hyper-Threading, we're still stuck with only two threads per core. Yes, the returns diminish after two threads, but programmers have written enough multithreaded software by now to make four threads per core worthwhile in a mainstream PC.

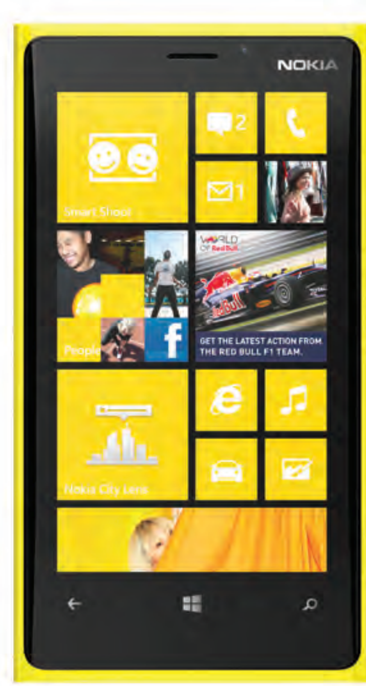
The most revealing POWER8 feature is its clock frequency. It will exceed 4GHz, which is fast, but no faster than many overclocked PCs. Fourteen years after Intel introduced its Pentium 4 NetBurst processor, we're still far away from its 10GHz promised land. That's why POWER8, despite its generous power envelope, must resort to pumping up everything but the CPU clocks. Even when cost is almost no object, multiprocessing and multithreading are the preferred paths to higher performance.

Tom Halfhill was formerly a senior editor for *Byte* magazine and is now an analyst for *Microprocessor Report*.

Microsoft Buys Nokia's Devices Division

Microsoft inked a deal in September to pay Finnish phone maker Nokia €3.79 billion for its phone business, plus an additional €1.65 billion to license the company's patents, for a total of €5.44 billion, or about $7.2 billion in US dollars. Microsoft hopes to accelerate the growth of its share and profit in mobile devices, both of which could use a boost. In related news, market research firm Kantar Worldpanel reported that the Windows Phone Store was processing 9 million transactions per month, a factoid that Microsoft repeated in a developer blog.

Around 32,000 Nokia employees will transfer to Microsoft, including 4,700 workers in Finland and 18,300 employees directly involved in manufacturing, assembly, and packaging of product worldwide. **–PL**



HDMI 2.0 Announced

At the IFA trade show in September, the HDMI Forum announced version 2.0 of the specification. Channel bandwidth gets a huge boost, from 3.4Gb/s to 6Gb/s, which will now allow 60Hz refresh rates at 4K resolutions, something that only DisplayPort 1.2 could achieve. We'll also be getting up to 32 audio channels—beyond overkill at home, but quite handy for movie theaters. To that end, HDMI 2.0 will also natively support a 21:9 display ratio. There is also a "dual video stream" feature that can take advantage of the combined 18Gb/s now available, but its functionality was not clearly defined at press time. Some current devices might get a firmware update to support the new spec. **–PL**



Dell Finalizes Sale to Its Founder

PC manufacturer Dell finalized a deal in September to sell the majority of its shares to founder Michael Dell for a cool $24.9 billion. He combined his efforts with private equity firm Silver Lake Partners. Mr. Dell already owned 16 percent of the company's shares but added $750M in cash to the purchase. He intends to take the company private, which he says will give the company more time to develop projects and will eliminate the focus on stock price as the main measure of his company's success. His campaign to buy the company was nearly derailed by billionaire Carl Icahn, who thought privatizing was a bad idea, and that the price tag was too low. **–PL**



Thomas McDonald
Game Theory

CAUSES AND EFFECTS

AS I WRITE, it's less than 24 hours since a gunman killed 12 at the Washington Navy Yard, and was then killed by police. As the details slowly emerge, we're learning a bit about the shooter, Navy petty officer Aaron Alexis.

He was known for his quick temper and anger issues. He suffered from post-traumatic stress disorder after rescuing victims on 9/11. He was paranoid and carried a gun everywhere, and would fire it now and then. He had hallucinations and was medicated for mental illness. He said he was the victim of racial discrimination. He claimed to have been screwed over by his employers (the US government). He played lots and lots of shooters.

If you think the media led with any other fact than the last, then you haven't been paying attention.

The human psyche is a work of such baffling intricacy that we still barely understand its functioning. All the myriad influences, experiences, memories, dreams, thoughts, and biological elements that combine to form our consciousness create complex networks that make it extremely difficult to really trace a motive for anything, from love to racial animus to homicidal impulses. The mind can be at once amazingly resilient and distressingly fragile.

Does the troubled mind drift to violent entertainment to calm it, or does the violent entertainment create the troubled mind? As an industry, we're so afraid of possible censorship that we're often reluctant to ask the hard questions. Did violent games affect the mind of Aaron Alexis?

Of course they did. Perhaps for the better, by allowing an outlet for violent impulses. Perhaps for the worse, by allowing dark thoughts to feed on murderous fantasies and thus grow.

Be certain of this: They did something. It's facile to blame video games for mass homicide, but it's equally facile to wave away the possibility that there was a relation between a man playing Call of Duty 16 hours a day and that same man gunning down 12 people.

Thomas L. McDonald is Editor-at-Large of Games Magazine.

Intel Announces Tiny 'Quark' Chip

In September, Intel showed off its new Quark system-on-chip (SoC), which is one-fifth the size of Atom SoCs and will use one-tenth the power; Intel claims it's the smallest chip of its kind. The company didn't reveal too many details of the new SoC, but said it would be open architecture, offer industry-standard software support, and be fully synthesizable. The chip is presumably x86-based. But because it's fully synthesizable, licensees would be able to customize the design with their own intellectual property. However, CEO Brian Krzanich says that licensees will not be able to customize the core itself.

Fully synthesizable chips also allow the chips to be fab-agnostic and could technically be made by foundries that Intel does not own. **–GU**

Valve Announces Game Sharing

Valve Software announced in September that it has added a game-sharing feature to its Steam download service. Dubbed Steam Family Sharing, the feature will allow you to share your entire game library with another person on your Steam friends list. However, you cannot play the same game at the same time. If the game owner starts to play a game that's already being "borrowed," Steam will notify the borrower that they must purchase the game to continue, or end their session. At press time, games could be shared with up to 10 other Steam friends. **–SW**



Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

GTA V
The long-awaited fifth installment of this "murder simulator" broke records with its $800 million take on day one. PC version, please!

WINDOWS PHONE
It's not taking over Android and iOS just yet, but has moved into a solid third place globally.

VALVE SOFTWARE
This month Valve added the ability to share your Steam catalog with up to 10 other Steam members. Hallelujah!

TRAGEDIES

MICROSOFT
Released a series of videos poking fun at the new iPhones, only to pull them down hours later, saying they were, "off the mark."

FACEBOOK
Sparked outrage by forcing user-posted videos to autoplay in news feeds, surely a dry run for inline video ads.

APPLE
The day after it announced its new iPhone 5C and 5s, its stock dropped 6 percent. The clock is ticking, Tim.

Internet Encryption Compromised

In September, the *New York Times* and UK paper *The Guardian* reported that the National Security Agency (NSA) and its UK equivalent Government Communications Headquarters (GCHQ) had "cracked much of the online encryption relied upon by hundreds of millions of people to protect the privacy of their personal data, online transactions, and emails."

The documents accessed by the two media outlets reveal that, at the turn of the century, the NSA began pouring billions of dollars into a secretive program code-named "Bullrun." Aimed at defeating online encryption, it stumbled on a major breakthrough in 2010, when the agency acquired the ability to decrypt "vast amounts of Internet data" that had been considered unexploitable up until that point.

The agency allegedly owes a lot of its eavesdropping capabilities to secretively influencing tech companies to alter their product designs, "insert vulnerabilities into commercial encryption systems," and weaken security standards. It's apparently a part of the SIGINT (signals intelligence) Enabling Project, which the NSA has spent around $800 million on since 2011.

Although no tech company is named in the documents, it is now known that the GCHQ is keenly working on "understanding" Hotmail, Google, Yahoo, and Facebook. In fact, in a quarterly update from last year, GCHQ seemed particularly excited about some new "access opportunities" where Google was concerned.

Microsoft says it is seriously concerned and will press the government for answers. Meanwhile, Google says it hasn't seen any evidence of its security systems being circumvented in any way and insists that "the security of our users' data is a top priority." **–PC**



Wireless USB Announced

The USB Implementers Forum announced in September that it was developing Media Agnostic USB (MA USB), designed to work on the 2.4GHz, 5GHz, and 60GHz bands for transfer speeds of up to 7Gb/s. This system will allow devices to use the USB protocol without requiring a physical USB connection. The high end will be reserved for a new protocol called "WiGig," which is being developed in collaboration with the Wi-Fi Alliance, the group that determines the industry standards for Wi-Fi, though such speeds will be intended for distances of a only few feet. Reportedly, the protocol will also work with WiMedia Ultra-Wideband radios. **–TM**

Tablet Sales Projected to Pass PCs

The International Data Corporation published a Worldwide Quarterly Smart Connected Device Tracker report in September that estimated tablets would begin outselling desktop and laptop PCs by the end of the year. By 2017, the IDC estimates that total PC sales will drop by 13 percent, while tablets will inhabit 16.5 percent of the device market; for reference, smartphones will take up an estimated 70.5 percent of this pie. And this year, the IDC says, the "global smart connected device" segment (smartphones, tablets, PCs) will generate $622.4 billion in sales. Since tablets are nearing the $100 mark, and smartphones can be had for free on contract, the news does not come as a shock. **–BV**



Quinn Norton
Byte Rights

SURVEILLING THE LAW

YOU KNOW what doesn't make any sense in a democracy? Laws that said democracy's voters aren't even allowed to look at. Because, well, democracy. We're supposed to decide what kind of laws we're cool with.

Secret laws don't make sense for building codes or traffic enforcement. We wouldn't accept it in our education system or social security. This seems obvious. But we have accepted secrecy for many years surrounding the laws that guide global (and domestic) electronic surveillance and the investigation of suspects. These laws and their interpretations (the practical part that guides what the G-men do) are classified. Not even most of Congress can see them.

If the nation can't see a law because of National Security, we've got to ask, who exactly is being secured, and from what? Because we aren't getting to vote on what security means to us. We don't even get to pick our representatives based on the laws we want to support, which is kind of the whole point of a republic. Secret laws keep us secure from our own democracy. Otherwise, we might vote for the wrong law: one that doesn't support out-of-control intelligence services surveilling with no public oversight!

Because sometimes to protect democracy, we have to obliterate it, then use the word a lot so people don't notice.

But there is some hope. Currently languishing in Congress are the Ending Secret Law Act and the FISA Accountability and Privacy Protection Act, both of which make some progress toward letting Americans see and therefore decide on laws that have life-or-death consequences—laws that have been used to surveil us all. But this effort needs people to step up, make calls, and get angry. It might be a good time to ask your congress-critter why some laws have more privacy than you do.

Quinn Norton writes about copyright for Wired News and other publications.

THE LIST

8 POSSIBLE REPLACEMENTS FOR STEVEN BALLMER

8

STEPHEN ELOP
Former Nokia CEO could be the perfect "devices" guy to lead MS into a new era.



7

TONY BATES
An MS-insider and former Skype CEO, he might have found his "calling."



6

SATYA NADELLA
A 21-year veteran and former Bing chief could improve the results of Microsoft's search.



5

QI LU
This former Yahoo exec currently heads Bing, Office, and Skype. Why not the whole enchilada?



4

JESSE EISENBERG
He did a great job fake-running Facebook, so we're sure he could fake it at Microsoft.



3

JESSE/ HEISENBERG
Assuming they're still alive when you read this, these two could certainly cook up some excitement at MS.



2

LIL BUB
We'd love to see her sitting on Ballmer's desk. Her face on the Start Button wouldn't hurt, either.



1

TONY STARK
Since he can do the impossible, he's needed to sell Surface tablets, Windows 8, and Bing.



HEAD TO HEAD

BY JOSH NOREM

Corsair Obsidian 900D vs. Cooler Master Cosmos II

The Cosmos II debuted in 2011 to much fanfare. Indeed, it was the chassis of our dreams. It housed our precious Dream Machine that year, and was easily the best "super-tower" available. In 2013, the Corsair 900D came on the scene boasting a similarly mammoth stature, and was itself chosen for Dream Machine duty due to its water-friendly nature and towering physique. Both cases represent the pinnacle of PC case design, so they must do battle.



Corsair's new Obsidian 900D "super-tower" is tall and roomy, but much less beefy than the Cosmos II.

ROUND 1

Size and Weight

Both cases are big, but it's how they carry their bulk that makes all the difference. The Cosmos II weighs 48 pounds, while the 900D weighs 41 pounds. The Cosmos II is 27.7 inches tall while the 900D is 27.2 inches, so the two are very close in size. To be honest, we originally felt that the Cosmos II was *too* heavy because it's built like a tank. Then we lifted the Corsair 900D out of its box and were a bit let down by its relatively light weight. It just feels too lithe for a case of its size, and there's no easy way to move it, whereas the Cosmos II has built-in handles, which makes transport much easier. Therefore, we give the Cosmos II the nod, because we wish the 900D had a bit more heft to it and an easier way to move it than squat and grunt.

Winner: Cosmos II

ROUND 2

Total Capacity

It's safe to say you'd need to have a drug cartel's bankroll to ever outgrow either of these cases, but it's still important to gauge overall capacity. For starters, the Cosmos II has 13 3.5-inch drive bays compared to the 900D's nine bays, though you can buy two more three-drive cages for a total of 15. The 900D has one additional 5.25-inch drive bay to its credit—four total. Both cases hold ATX and E-ATX mobos, as well as smaller boards, but the Cosmos II holds several larger variants, such as XL-ATX, SSI CEB, and SSE EEB. The Corsair 900D has room for dual PSUs, however, mounted vertically, whereas the Cosmos II can hold only one. Both cases have more than enough room for any combo of GPUs your bank account can tolerate. Since both cases are very evenly matched in this category, and can easily swallow even a Dream Machine, with room to spare, this one is a tie.

Winner: Tie

HEAD



The Cosmos II is one of the largest cases ever made, and has a shipping weight of 50 pounds.

ROUND 3

Build Quality

When you drop $350 smackaroos on a chassis, you expect top-notch build quality, and unfortunately only one of these cases lives up to that expectation, and that's the Cosmos II. Though both cases are made with a steel frame and feel extremely solid, the fit and finish of the Cosmos II seems much more polished than that of the 900D. With the Cosmos II, everything that moves glides smoothly, doors and latches lock into place tight and secure, and you never get the feeling that any part of the case is brittle or untrustworthy. The 900D, however, has two glaring weak spots—its disappointingly flimsy lower bay doors, and it's flaccid 3.5-inch drive-bay assemblies. Both of these rickety contraptions feel out of place on a chassis of this class, and require too much fumbling for our well-heeled tastes. The lower drive-bay doors are surprisingly wobbly, with a magnetic retention mechanism that barely works.

Winner: Cosmos II

ROUND 4

Cooling Options

If you're running air-cooling, both of these cases provide more mounting locations than you can shake a heatsink at, though they are modestly outfitted out of the box with just a handful of 120mm spinners. When it comes to liquid-cooling opportunities, though, the Corsair 900D is the clear winner, providing ample radiator mounting options on almost every surface of its spacious interior. Not only can you mount a 480mm radiator on the top *and* the bottom, you can put a 360mm rad in the front too, or two of them in the bottom if you're cray cray. The Cosmos II can handle a 360mm up top but there is no way to mount a radiator to the front of the chassis. You can also mount just a single 240mm rad down below due to the PSU's horizontal orientation, plus the Cooler Master provides mounting rails for only one radiator.

Winner: Corsair 900D

ROUND 5

Modularity

Cases such as these are not mere storage containers, but rather canvases that allow you to express your inner geek via expansion, modification, and customization. To that end, both cases are fairly modular, allowing you to remove fans and drive cages to install cooling components or to manage cables. The Corsair 900D lets you remove and rearrange pretty much everything, including the lower and upper drive bays as well as the PSU location. The Cosmos II, on the other hand, offers fewer options due to the PSU's location and the steel shelf that divides the chassis's lower quadrant. You can still remove the upper and lower drive cages, but your options for moving the drive cages around are limited. You also can't change the location of the power supply, nor can you add a second one if you need to, which is a situation we confronted while building this year's Dream Machine.

Winner: Corsair 900D

And the Winner Is…

As we come to the finish line both cases are tied, so the winner is not immediately apparent. After searching our souls, examining our PC fantasy builds, and consulting with our shaman we arrived at a winner—the **Corsair 900D**. It's the winner for one simple reason: It offers more flexibility for ambitious builders who want the option to expand their builds in the future, including running liquid-cooling, for which it's the best case around, period.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Mobo Mystery
> Rad Placement
> Disappearing Drives

Scooby Doo Mobo Moment

I've had some stability issues with my personal rig. I'll go to boot Win7, and after the loading screen I just get a black screen. When I go to reboot, it starts to power cycle as if there is an incorrect setting in the BIOS. Now, here's where it gets interesting. When I cycle the power by using the switch on the PSU, it will then boot into Windows on the first try! This entire process repeats itself every cold boot or restart. To me, this is screaming motherboard issues. I've already tested the RAM, and checked and double-checked all the BIOS settings. I'm really just curious about why cycling the PSU seems to fix things temporarily. What gives, Doc?

—Christopher Maciag

THE DOCTOR RESPONDS: Besides looking at your motherboard, you may also want to examine your PSU. It could be an issue with the unit's Power Good signal. This is the signal the PSU gives the motherboard that it's OK to start to boot. If the signal is incorrect or absent, it could very well cause the system to reboot.

You didn't give your motherboard's vintage, but if it's old enough to have bad capacitors, that could also be the issue. Get out a good flashlight and look at the capacitors, particularly those around the CPU. If they're bad, they may resemble a full Coke can left in your car on a very hot day.

x16 or Dual x8

The October article "Put It To The Test" answered whether a x16 PCIe slot ran faster than x8, but didn't really clarify what happens if you run SLI in two x16 slots. Do they function as two x16 or is there degradation so they run at less than that? I'm thinking about a Z87 Asus ROG Max IV Hero board for my next build. It says "x16 or dual x8" in its documentation. What does that mean for my big expenditure of two expensive video cards? Does the SLI bridge solve any performance problems between the slots?

—Chris Ajemian

THE DOCTOR RESPONDS: Many motherboards (well, actually the CPUs), including the ROG Maximus IV Hero, don't have enough PCIe lanes to run more than one video card at x16, so if you use two cards in SLI/CrossFireX each PCIe slot drops down to x8. The good news is that those slots are PCIe 3.0, which means that in x8 mode they each have the same bandwidth as a PCIe 2.0 x16 slot. You won't see any slowdown in your expensive cards. Even if your cards only have PCIe 2.0 connectors, the slowdown will be on the order of 1 or 3 percent. And the SLI bridge does solve performance problems between the slots, in that SLI will not work without it.

Should I Upgrade?

I've been sporting an Asus Maximus IV Extreme for a couple of years now, originally with a Sandy Bridge, upgraded to Core i7-3770K. I went all out with an EVGA GeForce GTX 590 because a) it was the most awesome at the time, and b) it supported three DVI connections on one card for my three LCDs (using 3D Vision on the primary Acer GD235HZ).

I feel compelled to upgrade to a Haswell Core i7-4770K and Asus Z87-Deluxe (just because I can). I can't decide the best way to utilize my three screens. Should I keep the GTX 590 as-is, or should I change out to a newer Nvidia 7xx series? Performance isn't currently a problem, but I'm always looking for something better. The GTX 590 is convenient because it's two GPUs with SLI on one card and connects all my screens. I'm having trouble finding a contemporary 7xx card that can connect the three screens without going with two cards. Any advice?

—Lord Chariot

THE DOCTOR RESPONDS: Well, milord, you could always save a few hours of build time and just light a few thousand dollars on fire. The Doc isn't sure the roughly 20 percent performance boost you get from that CPU/mobo upgrade is worth the $700 you're going to spend, especially if you have no complaints with your current

↘ submit your questions to: doctor@maximumpc.com

situation. But then, the same could be said of your desire to upgrade from the GTX 590. The only single-card upgrade that's actually an upgrade from where you're standing is the GTX 690. You'll get your three DVI ports and a substantial performance boost while remaining on a single card, but you'll spend $1,000 on the GTX 690. If it were the Doc, as long as we're spending money, we'd get two GTX 780s (or Titans, if we could afford them) and run them in SLI. Either config will get you more juice than a GTX 690, and the dual 780s will only cost you around $1,300. Or you could wait for the rumored GTX 790, which is probably your best bet. In the meantime, if you haven't already, invest in a nice big SSD for your OS and games. You can get a 1TB Samsung 840 Evo for less than $650.

Do Not Taunt Happy Fun Installer

I just read Chris Zele's Lab Notes about his issue installing Windows 8 with a storage drive (October 2013) and you may have administered the appropriate analgesic once again. I am on the verge of building a new computer with Windows 8 and have many storage drives that often get swapped. I was wondering if you have a best-policy recommendation for installing the OS in this situation. In the past, you have recommended installing Windows 7 with only one drive connected, so as not to confuse the installer. Would the same recommendation hold for Windows 8?

—David Porter

THE DOCTOR RESPONDS: Yep! Chris Zele's Lab Note related that he removed a storage drive after he installed Windows 8 and was unable to boot his computer until he replaced it, because the Windows boot record was located on that drive rather than his OS drive. It's a good policy to disconnect every drive but the one you intend to install Windows on before you begin the install process. Windows can't put your boot record on a drive it can't see. *Mwa ha ha ha ha*.

Where Does the Radiator Go?

I was attracted to the "Performance" build in your March 2013 issue (Blueprint), so I thought I'd try it. Now, I think I'm stuck. I have a Thermaltake New Soprano case, a Corsair HX850 PSU, which according to the Corsair website is the same size as the HX750 you used, and a Corsair H80i CPU cooler like you used. The trouble is I find I cannot fit them both into the case. There is only one place where the PSU can go, and the most appropriate place for the H80i would be next to the PSU on the bottom of the case where the second optional input fan would go. But it won't fit there. There is simply insufficient room between the PSU and the drive bays. If I were to try to mount the H80i at the top of the case, in place of the existing outflow fan, the radiator would cover the CPU. And I cannot see how one could dismount the 200mm fan in front of the drive bays and mount instead an H80i. How did you manage it?

—Bill Coomber

THE DOCTOR RESPONDS: It might not be obvious, but single-radiator liquid coolers like the Corsair H80i are typically installed in the rear exhaust fan mount, replacing the standard-issue rear exhaust fan. The Doc recommends removing the existing fan and installing it as an intake fan in the optional fan mount location at the bottom of the case. Then, install the H80i per Corsair's instructions, making sure both radiator fans are mounted as exhaust fans. Adding the original rear exhaust fan as an intake fan at the bottom of the case will help make sure you're getting adequate airflow into the case to prevent too much negative air pressure inside.



This photo from Thermaltake's website shows the standard placement for a closed-loop liquid-cooler's radiator.

Where Are the 7,200rpm Drives?

In the computer world, it seems like things generally keep getting faster and better. But I've noticed something amiss, Doc, as I shopped around for a laptop for my daughter. For years, 7,200rpm hard drives seemed to be the preferred choice, right? I know there were 5,400rpm drives around, and even the 10,000rpm higher-end drives, but most folks wanted 7,200rpm, paired with an SSD as the boot drive or caching drive. For some reason, everywhere I look, 5,400rpm drives seem to be the current standard in laptops. There are frequently other choices such as hybrid drives, and an occasional 7,200rpm drive, but the default is almost always a 5,400rpm HDD. Why have we taken a step backward here? With boutique vendors you have a lot more choices and can get 7,200rpm or hybrid drives in addition to your SSD. But my daughter is interested in an HP laptop, and they don't offer anything but a 5,400rpm drive or a 5,400rpm hybrid. Same for Dell and Lenovo. Why the resurgence of 5,400rpm drives all of a sudden? They are soooo slow.

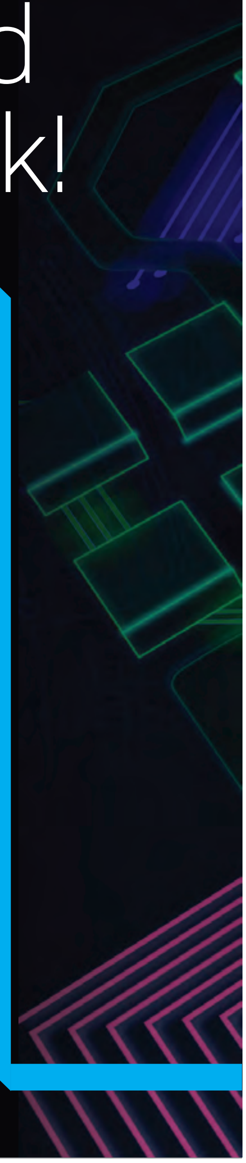
—K. Browning

THE DOCTOR RESPONDS: As you mentioned, SSDs have completely taken the speed crown from 7,200rpm laptop drives, and hybrid drives such as the Seagate Barracuda XT make a good middle ground between SSDs and HDDs by caching the most frequently accessed sectors to NAND. Seagate certainly thinks hybrid drives are the way forward, and is discontinuing 7,200rpm laptop drives entirely after this year. The company also finally has a decent consumer SSD. WD and HGST are still making 7,200rpms, but as to why OEMs aren't putting them in laptops, the Doc is guessing it's a combination of cost savings and power savings. Or it's just the price point you're looking at. A quick glance at Dell and Lenovo's websites reveals plenty of 7,200rpm drives in Inspirons and ThinkPads, and even HP offers 7,200rpm drives as upgrades on plenty of its mainstream laptops.

COMING

A family of unlocked processors, a slew of faster interfaces, new GPUs, and an Atom that doesn't suck!

MAXIMUM PC'S 2014 TECH PREVIEW

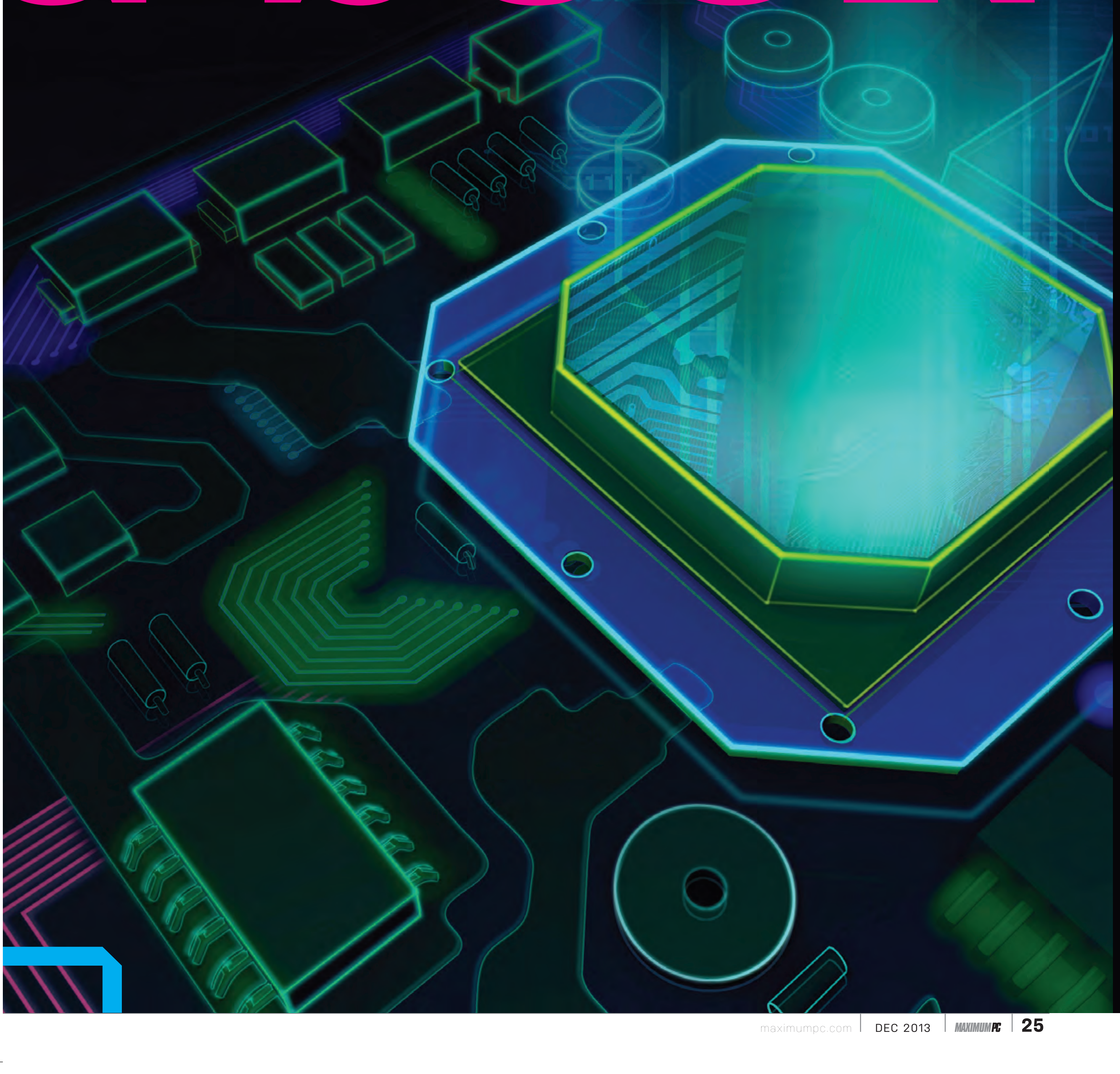


Part of being a Pure PC Power freak—a badge we wear proudly—is living in a constant state of anticipation and excitement over the next advance in performance. Because advances *always* happen. As surely as we can predict that Grumpy Cat will one day end up an even grumpier has-been with matted fur and a bad cat-nip habit, we can count on PC components to get ever smarter, ever faster, ever more refined, even if those advances aren't being live-blogged. That's just the way of technology, and yay for that!

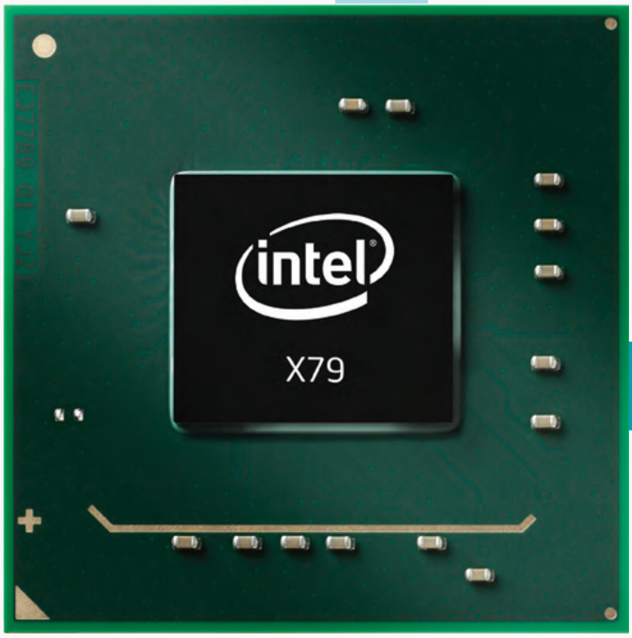
This month, we seek to uncover how this inevitable progress will play out for the PC over the coming year—what it will mean for our frame rates, bandwidth, and everyday workloads. With that in mind, we pressed our most trusted industry contacts for intel. We asked the tough questions; we even greased some palms. We also got hands-on with some upcoming hardware. In other words, we gathered a sufficient cache of intelligence to make some pretty good guesses and even a few outright assertions about the technology that will be rocking the worlds of PC enthusiasts in 2014.

BY THE MAXIMUM PC STAFF

G SOON



The X79 chipset is the one main weakness of Ivy Bridge-E and LGA2011, as it only offers two SATA 6Gb/s ports.



IVY BRIDGE, MEH?

INTEL'S ENTHUSIAST IVY BRIDGE-E IS HERE, BUT IT MAY NOT MATTER WITH HASWELL ON THE SCENE

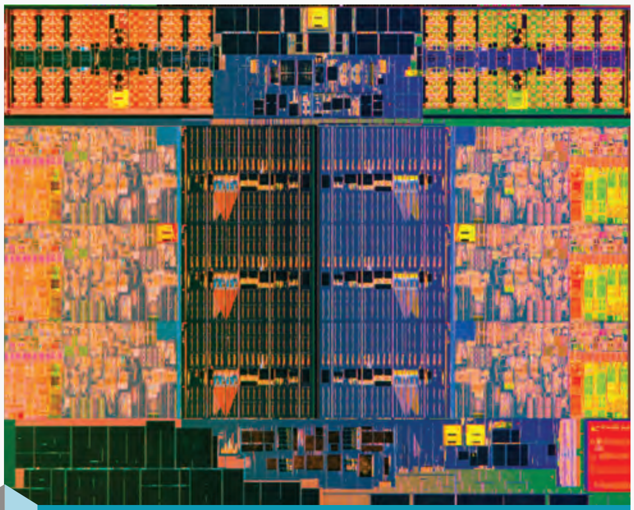
THE RELEASE OF Intel's Ivy Bridge-E series of chips is about as anticlimactic as you can get: It's a chip based on a microarchitecture that isn't just *going* out of style—it already *is* out of style. It's a bit like trying to woot over the 2011 coupe when it's sitting next to the 2013 model on the showroom floor.

But don't let all the negative waves get you down; IVB-E still has its advantages. As good as Haswell is, it can't be found in the big-boy socket LGA2011 trim—Haswell only slides into LGA1150 sockets. To make Ivy Bridge-E even sweeter, Intel has also taken the unprecedented move of offering all the new Ivy Bridge-E chips unlocked. Previously, only the Extreme Edition parts were "fully" unlocked and the LGA2011 K parts partially unlocked. This time around, even the four-core Core i7-4820K will be fully unlocked.

Of course, if you read our review of Ivy Bridge when it came out (umm... 16 months ago), you already know the story: 3D transistors, a newer 22nm process, and a healthy stride forward in graphics. But since Ivy Bridge-E doesn't have the graphics core, the only real bump is from the x86 side. Even there, Intel described the update as a marginal "tick" upgrade in performance.

Still, Ivy Bridge instantly replaced the Sandy Bridge parts as our go-to processor, even if it wasn't the 25 percent improved-performance high enthusiasts have been chasing since the Core 2 and Nehalem Core i7 days, and we expect the same to be true of Ivy Bridge-E: If you're building a new machine, there's simply no reason to buy Sandy Bridge-E unless you're getting a hell of a price on it.

The platform itself still has an edge over the Haswell Core i7-4770K platform. With its quad-channel memory controller, you can pack up to 64GB on LGA2011 boards—Haswell is limited to 32GB. Those who need a buttload of PCIe expansion should also look to Ivy Bridge-E with its 40 lanes of PCIe goodness—Haswell offers but 16. And yes, Ivy Bridge-E finally brings "official" PCIe 3.0 support. Intel would never certify PCIe 3.0 on Sandy Bridge-E, though it could be enabled with a hack; with Ivy Bridge-E, it's official.



Unlike Sandy Bridge-E CPUs, which use eight-core chips with two cores turned off, Ivy Bridge-E CPUs feature just six cores.

The other good news is that it looks like Ivy Bridge-E is a drop-in part. Just update the board's UEFI to one that supports Ivy Bridge-E and drop in the chip. That is, as long as you're not rocking an Intel X79 board. With Intel exiting the motherboard business, there's literally no one left to update its X79 boards to support Ivy Bridge-E on the LGA2011 DX79SR. Folks with Asus, Gigabyte, et al, however, should be fine.

Inside the CPU, Intel basically took the Ivy Bridge microarchitecture and designed it around six cores instead of four. Like Ivy Bridge, there's a bit of a reduction in overclocking headroom. Many Sandy Bridge and Sandy Bridge-E parts could reach up near 5GHz with enough cooling. Ivy Bridge-E doesn't clock-up quite as high but also doesn't seem to hit the same issues that overclockers had trying to push Ivy Bridge CPUs to the 5GHz mark. The reason could be the larger die size. With its additional two cores, Ivy Bridge-E CPUs have more meat to put in contact with the heat spreader. Some have speculated that Intel's cheapening of thermal compound hurt the original Ivy Bridge parts' overclocking capability, but we think the jury is still out on that since we've seen evidence that it didn't really matter what the thermal compound was.

Ivy Bridge-E also offers significant power savings over Sandy Bridge-E components. We've generally been pretty indifferent to power savings on platforms designed to run 64GB of RAM, four hard drives, two SSDs, two GPUs, and enough fans to qualify as a S.H.I.E.L.D. Helicarrier, but Ivy Bridge-E power savings is a noticeable 25 percent by all reports. That's nothing to sneeze at when your box is sucking down 150 watts at idle.

Perhaps the sleeper feature in IVB-E is the per-core overclocking. This lets you fine-tune overclocks from within the OS in real time. With Sandy Bridge-E, OS-based overclocks required a reboot to take effect. With Ivy Bridge-E, a chosen overclock is immediately executed.

CPUs COMPARED

	Core i7-4960X	Core i7-3960X	Core i7-990X	Core i7-4770K	Core i7-3770K	Core i7-2700K
Clock	3.6–3.9GHz	3.6–3.9GHz	3.46–3.7GHz	3.5–3.9GHz	3.5–3.9GHz	3.5–3.9GHz
Microarchitecture Code-Name	Ivy Bridge-E	Sandy Bridge-E	Gulftown	Haswell	Ivy Bridge	Sandy Bridge
Cores/Threads	6/12	6/12	6/12	4/8	4/8	4/8
Transistor Count	1.86 billion	2 billion	1.17 billion	1.6 billion	1.4 billion	995 million
Die Size	257mm^2	435mm^2	240mm^2	177mm^2	160mm^2	216mm^2
L2 Cache	1.5MB	1.5MB	1.5MB	1MB	1MB	1MB
L3 Cache	15MB	15MB	12MB	8MB	8MB	8MB
Process	22nm	32nm	32nm	22nm	22nm	32nm
TDP	130 watts	130 watts	130 watts	84 watts	77 watts	95 watts
Socket	LGA2011	LGA2011	LGA1366	LGA1150	LGA1155	LGA1155
Memory Controller	Quad-channel	Quad-channel	Dual-channel	Dual-channel	Dual-channel	Dual-channel
Price at Launch	$990	$990	$995	$339	$317	$332

It's possible that eventually you'll be able to overclock cores based on the applications that are launched. If a game uses only two threads, you could potentially overclock two cores to far higher clock speeds because you know the other cores won't be hot.

No matter what, Ivy Bridge-E isn't a game-changing chip. For that to have happened, Intel would have had to offer an eight-core version of the CPU with a high TDP. It would have required liquid cooling to run overclocked but it would have given the power users, the enthusiasts, the red meat they've been craving.

Still, Ivy Bridge-E is not a step backward; it's a step forward. To find out how much of a step forward, read on.

MEET THE IVY BRIDGE-E CLAN

	Core i7-4960X	Core i7-4930K	Core i7-4820K
Clock	3.6–4GHz	3.4–3.9GHz	3.7-3.9GHz
Cores/Threads	6/12	6/12	4/8
Cache	15MB	12MB	10MB
TDP	130 watts	130 watts	130 watts
Price	$990	$555	$310

IVY BRIDGE-E BENCHMARKED

For our tests, we used the same GPU, same driver, and same SSD across all the different platforms, running Windows 8.1. We limited our CPU choices to the natural competition for the new Core i7-4960X: the six-core Core i7-3930K and the four-core Core i7-3820—both on LGA2011. We also decided to throw in the new Haswell Core i7-4770K and the original four-core Ivy-Bridge Core i7-3770. For additional perspective, we also tossed in a dual-core Ivy Bridge Core i3-3220 CPU.

If we had to absolutely declare a winner, we'd call it for the new Core i7-4960X, with the Haswell Core i7-4770K coming in a very close second. But the full performance story is far more complicated. Looking at just the single-core performance in Cinebench 10, the Core i7-4960X is pretty much on par with the Core i7-3770K. When you get to heavily multithreaded tasks, the six-core Core i7-4960X rules them all. The problem is that while the six-core chip more than pulls its weight in video encoding, 3D modeling, and other workstation-level apps, the Core i7-4770K is the better choice for most everything else. And let's face it, the vast majority of people aren't transcoding video all day long, so for them it makes sense to go with the modern chipset and generally better performance in most apps and games.

IN OTHER CPU NEWS...

For desktop computing, the next year should be fairly steady. Intel will continue to push LGA1150 as its primary mainstream platform with its Haswell CPUs. And as you've read, Ivy Bridge-E handles enthusiasts' needs for the rest of 2013 and well into 2014. LGA2011, though, will likely be replaced later next year with LGA2011-3. If you're an LGA2011 user, it's not really clear if the two sockets are compatible. What we do know is that LGA2011-3 supports DDR4. Some leaks have indicated there may well be some backward compatibility, allowing you to drop a Haswell-E into an Ivy Bridge-E socket, but we don't think that's very likely. It would require Intel to build DDR3 memory controllers into all of its CPUs to offer the compatibility. Intel has long shown a propensity for requiring consumers to buy a new motherboard, too. Witness the multiple, multiple chipsets for LGA775, not to mention the LGA1156 to LGA1155 move.

And frankly, as much as we like socket compatibility, we're not so sure it would make sense here. To quote Captain Marko Ramius: "When he reached the New World, Cortes burned his ships. As a result, his men were well motivated." LGA2011 is two years old and woefully lacking in modern amenities such as USB 3.0 and more than two SATA 6Gb/s ports.

Historians, however, would tell us that Captain Ramius was wrong and Cortes did not burn his ships, so maybe, just maybe, Intel will offer Haswell-E with support for LGA2011.

In AMD land, there have been murmurs that the company may put a stake in AM3+ by not offering its upcoming Steamroller microarchitecture in AM3+ trim. The question has been rolling around the Internet for months, with many speculating that AMD will indeed backpedal on its earlier commitment to support AM3+ through another CPU cycle. We tried to get clarification from AMD, but the company gave us no real guidance. One good sign is that our chats with vendors seem to indicate that nothing has changed on the AM3+ roadmap, so maybe, just maybe, we'll see another AM3+ part next year.

That doesn't mean we're not recommending the Core i7-4960X. In fact, there are a few areas where the chip can't be touched by anything else. The per-core overclocking tied to applications might also mature to the point where it easily spanks the four-core chips in less-threaded tasks, too. We'll go with the same recommendation we've been making for a while: If you make a living pushing pixels, or need access to more RAM and a lot of PCIe lanes for add-in cards, go with Core i7-4960X or the Core i7-4930K. If your workloads are more conventional and you primarily game with two or fewer graphics cards, Core i7-4770K is the more prudent path based on price-to-performance ratios. Folks on tighter budgets, or those who are 90 percent gamers, who don't need the threads for encoding or transcoding, should consider the Core i5-4670K.

One final scenario would be if you're building a box for personal use and intend to upgrade to a six-core or possibly even eight-core Xeon in the future, then the LGA2011 with a Core i7-4820K gives a good upgrade path for those who need more cores.

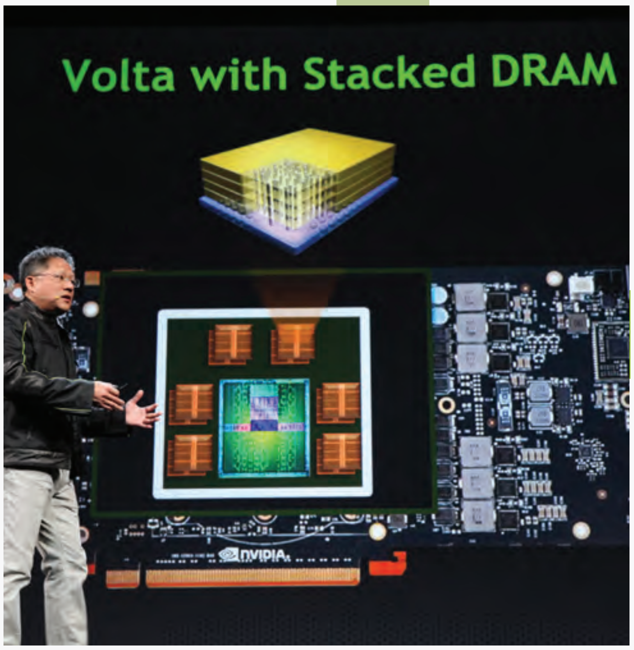
We don't want to leave you with the wrong impression, though: The Core i7-4960X is without a doubt the fastest CPU in town. It does it with less power than previous chips, and for those who really want to roll a mega-gaming machine with four GPUs in it—there's really no other choice. But we'd be far happier if the CPU came out six months ago and, frankly, if there had been an option for an eight-core CPU version.

BENCHMARKS

	3.6GHz Core i7-4960X	3.2GHz Core i7-3930K	3.5GHz Core i7-4770K	3.5GHz Core i7-3770K on Z77	3.6GHz Core i7-3820	3.30 Core i3-3220
PCMark 7 Score	5,964	5,606	**6,348**	5,902	5,607	4,816
PCMark 7 Lightweight	6,430	6,161	**6,741**	6,260	6,258	5,594
PCMark 7 Productivity	6,013	5,457	**6,274**	5,804	5,524	4,335
PCMark 7 Computation	9,075	8,797	**9,454**	9,179	8,834	8,053
Cinebench 10 Single-Core	7,124	6,259	**8,240**	7,037	6,275	5,882
Cinebench 10 Multi-Core	**39,317**	34,533	31,581	27,743	24,816	12,803
Cinebench 11.5	**12.18**	10.9	8.88	7.95	7.38	3.35
POV-Ray 3.7 RC7 (sec)	**120.84**	134.7	157.1	182.4	198.5	427.0
Fritz Chess Benchmark (times faster than 1GHz PIII)	31.27	29.5	**32.32**	30.48	29.57	13.2
Fritz Chess Benchmark (Kilonodes/sec)	15,008	14,160	**15,514**	14,631	14,191	6,334
Stitch.Efx 2.0 (sec)	784	872	**772**	868	959	1,337
PhotoMatix HDR (sec)	**164**	192	184	224	260	478
Premiere Pro CS6 (sec)	**1,848**	2,012	2,522	2,830	2,996	6,640
ProShow Producer (sec)	1,404	1,461	**1,314**	1,469	1,531	2,017
TechARP X264 5.01 Pass 1 (fps)	**112.3**	99.9	84.8	76.2	71.03	35.1
TechARP X264 5.01 Pass 2 (fps)	**23.1**	20.8	17.5	15.3	13.95	6.6
HandBrake 0.9.9 Blu-ray Encode (sec)	**788**	866	1,068	1,181	1,531	2,700
7-Zip 64MB load 12 threads (MIPS)	3,014	2,791	**3,076**	2,978	2,893	N/A
7-Zip 64MB load 8 threads (MIPS)	**3,678**	3,359	3,102	3,059	2,831	2,543
Sandra RAM bandwidth (GB/s)	**41.12**	**41**	20.3	20.1	38.2	20.6
Sandra L1 Cache (GB/s)	825.6	780	**1,001**	544	524	231
Sandra L2 Cache (GB/s)	**517.5**	483	380	321	304	137
Sandra L3 Cache (GB/s)	**299.5**	266	203	198	163	82
Valve Particle Test (fps)	**319**	286	226	209	198	111
3DMark 2011 Score	**X2,231**	**X2,231**	X2,209	X2,189	X2,217	X2,130
3DMark 2011 Graphics	1,985	1,988	1,976	1,964	**1,989**	1,963
3DMark 2011 Physics	**13,074**	11,984	9,876	9,887	8,844	4,188
3DMark 2011 Combined	2,074	**2,675**	2,668	2,617	2,672	2,642
3DMark Firestrike Overall	**4,658**	4,638	4,618	4,540	4,549	4,208
3DMark Graphics	5,014	5,015	**5,045**	4,980	5,021	4,977
3DMark New Physics	**14,996**	13,656	11,598	10,514	9,802	4,733
Resident Evil 6 low quality (fps)	12,098	12,110	**13,644**	13,333	12,022	11,032
Dirt 3 low quality (fps)	184.0	184.5	**243.2**	181	178	149.9
Hitman: Absolution low quality (fps)	**85.5**	79.2	77.1	77.9	74.7	53
Total War: Shogun 2 CPU test (fps)	**41.4**	37.7	**41.3**	37.6	35.2	23.6

Best scores are bolded

After Maxwell comes Volta, which will feature DRAM placed on the same silicon substrate for insane memory bandwidth.



NVIDIA GETS BUSY WITH MAXWELL

NOT MUCH IS KNOWN ABOUT THE SUCCESSOR TO KEPLER, BUT WE DO KNOW IT'LL BE THE FIRST GPU OF ITS KIND

AS WE CLOSE the year 2013, Nvidia has just finished launching its second round of Kepler cards in the GTX 700 series. We believe there are still two cards coming in that series, for the low end and the high end, and then the company will move on to Kepler's successor, code-named Maxwell. Though we don't know much about this new architecture yet, we are fairly confident it will be the first GPU to be offered using TSMC's new 20nm lithography process. There is speculation that delays in getting 20nm up and running might cause Nvidia to stick with the current 28nm process for Maxwell, but it seems impossible for the company to achieve the kind of generation-to-generation performance improvements it needs to have by sticking with the same 28nm process it used for its Kepler technology. Furthermore, Nvidia has always switched to a smaller process for a new generation of GPUs (Fermi was 40nm, Kepler was 28nm). The move to a smaller process will bring the traditional benefits: higher performance along with significantly reduced power consumption. If you thought Kepler was amazing at performance-per-watt, Maxwell could be twice as efficient, if not more so.

Of course, smaller process, faster, more efficient… all of that is expected, but what will really set Maxwell apart from every GPU that has come before it are two things. First, it will be the first GPU to sport a 64-bit ARM CPU that Nvidia has been developing for many years now, named Project Denver. The CPU will be integrated into the GPU die and it's referred to in reports as a "general-purpose core." Second, the key feature of the entire Maxwell architecture is something Nvidia calls "Unified Virtual Memory," which will allow the GPU and CPU to share a common pool of memory. The goal of the memory pool is to allow the CPU to access the ultra-fast GDDR5 memory used by GPUs, and vice versa. Both the host CPU and GPU will still write to their own memory, but the two will now share a "virtual" layer of memory that both can access.

The shared memory will improve performance over a wide range of applications since, theoretically, data will no longer need to be copied to and from the GPU and CPU to be processed. It's also likely that the main beneficiaries of this technology are devices that integrate a GPU and a CPU, such as tablets, smartphones, and the like. In fact, Nvidia's mobile roadmap indicates that two generations from now, its Tegra chip, code-named Parker, will employ both a Denver CPU and a Maxwell GPU, so the move to integrating a CPU with the GPU is clearly a form of convergence that Nvidia can drop into another platform. Whether or not Project Denver will benefit gamers remains to be seen, as most reports indicate it's primarily something that's needed for server applications and other compute applications. In fact, it's apparently so compute-specific that there is speculation that lower-end Maxwell GPUs will forego the ARM CPU altogether.

After Maxwell, Nvidia will introduce an architecture named "Volta" that moves the GPU's DRAM directly onto the same silicon substrate as the GPU die, which will dramatically increase bandwidth and reduce latency since the DRAM will literally be right next to the GPU die. It will pave the way for a memory bus that is 1,024 bits wide, for example, with memory clocked at 8GHz. Nvidia says it expects memory bandwidth up to 1TB/s for Volta—for reference, the GTX Titan currently allows up to 288GB/s, so Volta will be significantly faster.

Going back to the GTX 700 series, when Nvidia launched the GTX 760, it made a point of noting it was done launching products for the summer, which was odd. The company usually leaves these things open in case it needs to counter-attack a surprise AMD launch, but summer has come and gone with no word from AMD or Nvidia. However, there are still two massive holes in the 700-series lineup, at both the high end and the low end. Reports indicate we'll be seeing both a GTX 750 Ti coming in at $200 or so to replace the GTX 650 Ti, and that we'll also get a dual-GPU behemoth, as well. Nvidia has always had a dual-GPU card bearing two of its fastest cores in its lineup, and so far hasn't announced anything for its 700-series cards, leaving us to speculate about the GTX 790. We don't think it'll consist of dual Titans due to cost, but dual GTX 780s is certainly possible. Whether Nvidia can make this card squeeze into the $1,000 price-tag dress these cards have always worn remains to be seen, but our guess is that AMD's new GPUs will put enough pressure on Nvidia to release the hounds.

AMD REBRANDS, LAUNCHES R-SERIES GPUS

HERE COMES THE R9 290 GPUS

AMD WASN'T QUITE ready to spill all the beans on its upcoming "Volcanic Islands" GPUs as we went to press, so by the time you read this some of these details may have changed. Don't blame us—it's the nature of the secretive beast that is the world of GPUs. Nothing is really "final" on a GPU until it ships to customers, so manufacturers usually like to talk about a certain product in broad strokes first, then eventually send some specs, then actually launch with pricing and specs confirmed. It's known as a "paper launch" and that's what AMD is doing with its newest series of GPUs. That said, here's what we know so far.

THE R9 290 'HAWAII' DEBUTS

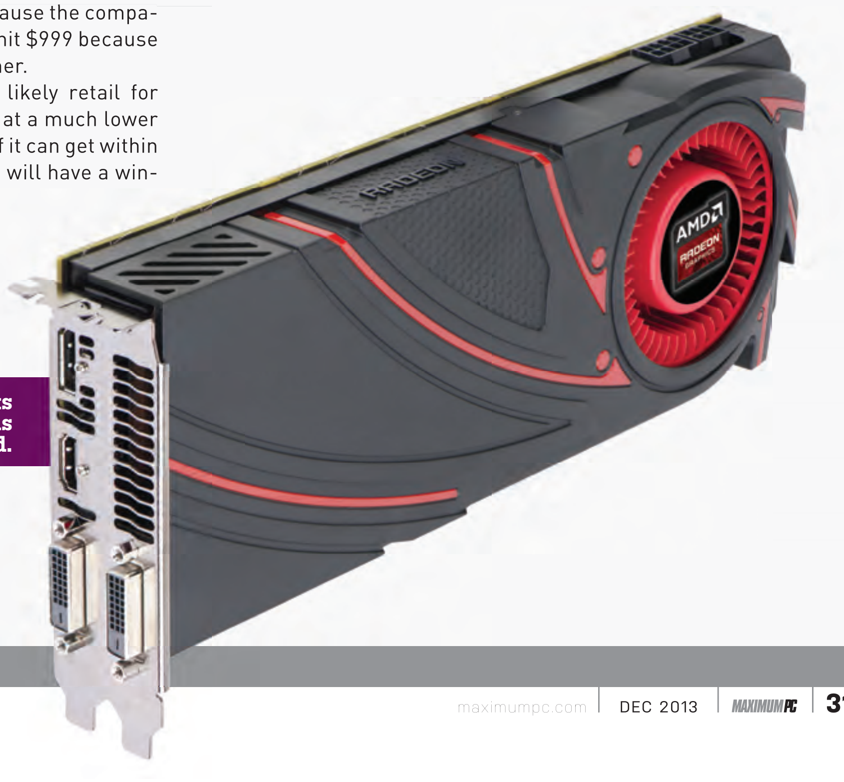
First of all, AMD is ditching its HD 7xxx series moniker for good, and switching to something with more room to grow in the future. In its place AMD will be placing an "R" prefix along with a three-digit number that tells you where each card stacks up in its hierarchy. Though we don't know the specific numbers of all the classes, we do know the following: The high-end cards will be called R9 290 and R9 290X, and that is confirmed by AMD. The company also confirmed that it will offer a midrange R7 and an entry-level R5 lineup, as well. The majority of these GPUs will be based on AMD's current GCN silicon—still at 28nm since it says 20nm just isn't quite ready yet—but rebadged and clocked higher.

There will be one new piece of silicon, however, and AMD is calling it Hawaii (the previous GPU was named Tahiti, for what it's worth). As we stated above, it'll be an all-new 28nm die that is bigger than Tahiti but not quite as big as Nvidia's GK110. We know it won't be as big because AMD has said as much in an interview on Forbes.com. AMD's general manager of graphics said it's about 30 percent smaller than GK110, and that the company believes it has the "best performance for the die size" for any enthusiast GPU. We expect AMD to keep its HD 7990 as the dual-GPU "ultra-enthusiast" card for this generation of cards, because the company has stated that its next batch of GPUs will not hit $999 because that's too expensive to appeal to the average gamer.

The top-tier Hawaii GPU, the R9 290X, will likely retail for around $600, where it will take on the GTX Titan at a much lower price point. That's still a heck of a lot of coin, but if it can get within striking distance of the Titan for $400 less, AMD will have a winner on its hands. Coming in just below the R9 290X will be the regular R9 290, which will probably arrive at $450 and face off with the GTX 780. Both R9 GPUs will most likely utilize a 384-bit memory bus, and be clocked lower than 1GHz.

TRUEAUDIO AND EYEFINITY

AMD is also highlighting two new technologies that it's going to include with its new series of GPUs, and both should make for an overall better experience for AMD GPU owners. The first doesn't have a name (that we are aware of) but simplifies hooking up Eyefinity setups. In the past, you had to plug the third monitor (and fourth, if that's how you roll) into a DisplayPort connector, no ifs, ands, or buts. AMD says that requirement has been eliminated, so you can plug them into any open port on the card. The second big feature, and this is something AMD is going to really push hard with this generation of GPUs, is all-new programmable audio technology named TrueAudio. This is hardware built into the GPU that features a three-core DSP baked into the graphics core, and optimized by game developers to give specific games an "audio signature," according to AMD. It's very similar to the TressFX technology from Tomb Raider, or how PhysX is implemented in certain Nvidia games, in that it's another tool in the chest for game developers to use to enhance the gaming experience. AMD says it will accomplish three goals, which include improving acoustic characteristics of environments, increasing the number of available sound effects by offloading the sound processing from the CPU, and generating truly directional audio, even when using stereo headphones. AMD says its TrueAudio technology can also piggyback on whatever you are currently using, whether it's USB or a discrete audio card. Though this new technology sounds great (pun intended), it's something developers will have to develop for on a game-by-game basis using models AMD is providing, so its implementation in games won't be automatic.

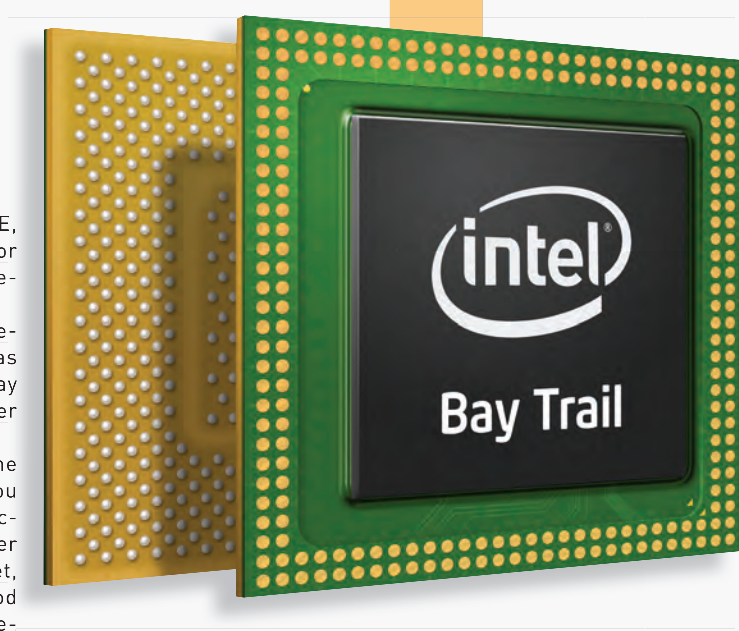


AMD's new R9 290X GPU sports an all-new cooling shroud that is smaller than we anticipated.

The Bay Trail Atom is a system-on-chip but this design won't include an LTE radio—yet.

ATOM PART DEUX

EXPECT WAVES OF INEXPENSIVE X86 TABLETS TO FOLLOW



SURE, ENTHUSIASTS are excited to finally get Ivy Bridge-E, and even giddy over Haswell, but the most important CPU for Intel this quarter might actually be its lowly Atom chip, code-named Bay Trail.

Bay Trail is a true redo of Atom, which was originally designed to power those horribly sucktastic netbooks, from as far back as 2007. The biggest architectural change for Bay Trail is its adoption of an out-of-order design CPU core, rather than the in-order design Atoms have used previously.

What's the diff? Think of an in-order CPU as a buffet line where you politely wait your turn as the person in front of you gets his rubbery chicken, mashed potatoes, and steamed broccoli. Even though you don't want any of that and would rather jump straight to the chocolate brownie at end of the buffet, you're forced to wait for the doddering fools in front you to plod along. With an out-of-order design CPU, it's a Las Vegas free-for-all buffet. There's no line to politely wait in, you can just jump straight to the dessert with no raised eyebrows or glares from your wife.

Out-of-order CPU designs have traditionally yielded the most performance but they also cost more in power consumption. That's one of the reasons Intel initially chose to build the original Atoms as in-order chips. In fact, most ARM SoCs powering tablets and phones have been in-order design until recently. But with Intel and ARM customers all using performance as a key metric for comparing tablets and phones, out-of-order has become the order of the day. It doesn't come without costs, though. As ARM chips have adopted higher-performance techniques, they've also started to consume more power.

This is where Intel hopes it can finally catch a break in its war with ARM, and Bay Trail is the CPU it hopes will turn the tables in its favor.

Bay Trail promises to offer CPU performance that crushes the fastest ARM chips, while providing the power efficiency we've come to expect from tablet SoCs. In tests of the Atom Z3770, the chip consumed 2.6 watts while running Cinebench 11.5 in Windows 8.1.

Besides power, another challenge for Bay Trail will be pricing, but Intel has apparently risen to that challenge, too. Tablets using Bay Trail chips are starting to hit the market at amazingly attractive prices. Asus just announced its Transformer Book T100. The Windows 8.1 convertible features a 10.1-inch IPS panel at 1366x768 and comes with the Bay Trail–based Atom for $349 with 32GB of storage. And that is but one of the many Bay Trail–Atom tablets expected by this holiday season—Intel predicts Atom-based tablets to hit as low as the $100 mark (which OS, the company didn't say). But will Bay Trail tablets be enough to turn around the tepid consumer demand for Windows 8? We'll have to wait and see, but Intel also expects manufacturers to build tablets around the x86-version of the Android OS. Take Dell's new Venue 7/8, for example, which will feature the Android OS, an IPS screen, and an Atom CPU for $150, with 16GB RAM.

The final question for Bay Trail is its performance. We had a choice of two options for benchmarking Intel's new Bay Trail SoC: with Windows 8.1 or with Android 4.2.2. Frankly, no matter what you think of Windows 8/8.1, competing with AMD isn't Intel's problem—it's competing with the dozens of ARM vendors on Android. To get a feel for how Bay Trail will fare in that arena, we used a reference design tablet from Intel equipped with an Atom Z3770 and running Android 4.2.2. The tablet itself is simply a Windows 8.1 tablet with a custom loader to allow the unit to boot Android. And no, you probably can't dual boot Windows 8.1 and Android, from what we're told.

We compared the Bay Trail reference tablet to both the

NEW VS. OLD: BAY TRAIL COMPARED TO CLOVER TRAIL+

	Atom Z3770	Atom Z2580
Code-name	Bay Trail	Clover Trail+
Process	22nm	32nm
Die size	Not disclosed	65mm2
Transistor Count	Not disclosed	140 million
Clock Speed	1.4–2.4GHz	1.3–2GHz
RAM	LP-DDR3/1067	LP-DDR2/1067
Max RAM	2GB	2GB
Cores/Threads	4/4	2/4
L2 Cache	2MB	1MB
Graphics	Intel HD Graphics	Power VR SGX544MP2
Max Res Support	2560x1600	1900x1200

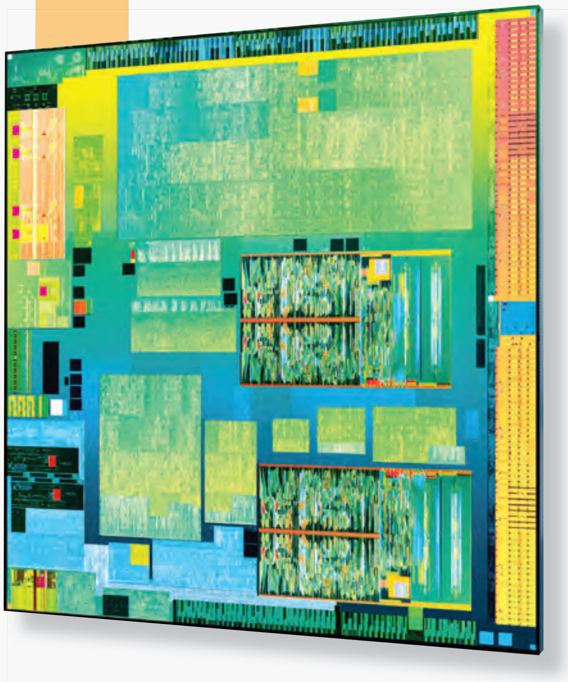
original and 2013 versions of the Nexus 7 as well as Nvidia's Shield. The Shield runs the new Tegra 4; the Nexus 7 Mk. I is powered by a Tegra 3; the Nexus 7 Mk. II features a Qualcomm Snapdragon S4 Pro. Android benchmarks are far from the maturity of PC benchmarks, so we cast a pretty wide net to gauge performance of the Bay Trail SoC.

Once we crunched the numbers, we decided that in tablets, the Bay Trail pretty much crushes the competition in graphics and CPU performance—including the Snapdragon S4 Pro in the Nexus 7 Mk. II, which is considered among the fastest, if the not the fastest, SoC running in Android trim today.

But, you're saying, Nvidia's Tegra 4 actually manages to clock-block the Bay Trail in numerous benchmarks. Yes, it's true that the Tegra 4 outpaces the Bay Trail in graphics performance, but on CPU performance, it's pretty much even. The graphics difference is also fairly close. In 3DMark, for example, the Bay Trail platform is about 45 percent faster than the S4 Pro chip in the Nexus 7 Mk. II while the gap between Tegra 4 and Bay Trail is only about 10 percent. It's also a back-and-forth between Bay Trail and Tegra 4 in the compute-intense tests. Finally, let's also point out that the Shield is actively cooled and features honking-large batteries. It's a gaming device, not a tablet. Whether you can keep a Tegra 4 clocked up at the Shield's levels in a thermally and power-constrained tablet remains to be seen.

What we can conclude from our Bay Trail testing is that 2014 will see x86 finally taking the fight to ARM in tablets in a truly competitive way. The game is far, far from over, but from the looks of it, it's a real ball game now.

Think of Bay Trail as more of an Ivy Bridge Lite, with its 22nm process and microarchitecture that borrows more from Ivy Bridge than Haswell.



CPUs COMPARED

	Intel Bay Trail reference tablet	Google Nexus 7 (Mk. II)	Google Nexus 7 (Mk. I)	Nvidia Shield
OS	Android 4.2.2	Android 4.3	Android 4.3	Android 4.2.1
SoC	Intel Atom Z3770	Qualcomm Snapdragon S4 Pro	Nvidia Tegra 3 T30L	Nvidia Tegra 4
3DMark Ice Storm Unlimited	15,185	10,659	3,213	**16,657**
An3DBenchXL Total	48,315	37,896	35,291	**49,009**
GFXBench 2.7.2 T-Rex HD Offscreen	16	15	3.2	**24**
GFXBench 2.5 Egypt HD Offscreen	41	40	9.8	**65**
Antutu 4.0.1	36,174	20,510	13,403	**40,541**
Geek Bench 3 Single-Core	**973**	579	341	921
Geek Bench 3 Multi-Core	**3,000**	1,852	1,115	2,923
MobileXPRT	**250**	152	120	226
MobileXPRT Apply Photo Effects (sec)	**30.84**	44.25	53.88	36.83
MobileXPRT Create Photo Collages (sec)	**12.2**	17.33	22.6	17.97
MobileXPRT Create Slideshow (sec)	**19**	36	45	21
MobileXPRT Encrypt Personal Content (sec)	55.58	110.26	121.69	**50.69**
MobileXPRT Detect Faces to Organize Photos (sec)	7.44	11.88	17.58	**6.99**
Sunspider 0.9.1 (ms)	625.8	1,215	1,392	**534.8**
GUIMark 2 Vector Chart Test HTML5	**12.98**	5.67	6.49	9.84
GUIMark 2 Bitmap Gaming Test HTML5	33.19	14.41	16.19	**39.24**
GUIMark 2 Pixel Stroke HTML5	**34.24**	22.87	16.47	33.04
GUIMark 2 Text Column Test HTML5	8.37	5.52	4.66	**11.45**
Vellamo HTML5	WNR	1,590	1,366	**2,881**
Vellamo Metal	1,120	698	358	**1,162**

Best scores are bolded.

SATA EXPRESS AND NVME

A MUCH FASTER INTERFACE AND PROTOCOL LOOM ON THE HORIZON

LAST YEAR, WE were nudging the limits of what the SATA 6Gb/s interface can offer, and now that we are nearing the end of 2013, there's a pileup of SSDs all pushed right up against the interface's bandwidth ceiling. The bad news is, this situation is not likely to change much in 2014 because even though *Maximum PC* readers all want faster SSDs, the majority of the market is still using mechanical hard drives, and we're going to need a new interface/connector, a new protocol, and a new command set to really move forward, and all those things will take time to implement. The good news is that the industry is slowing beginning to move in the direction of an all-new storage subsystem, which will jettison both the SATA bus and the AHCI standard in favor of a solution with much more bandwidth. But swapping out connectors and interfaces is no small matter, and unfortunately it will be a few years before we're all rocking something bigger and better.

When this new interface arrives, probably in 2015, it will be called SATA Express (SATAe), as the industry as a whole has decided that PCI Express is the chosen interface for the future of storage due to its scalability and the fact that it's already implemented in modern chipsets. The reason it's called SATA Express is that it's a bridge between the past (SATA) and the future (PCI Express), and will feature an interface that accepts both types of devices. There have been drives that bridge the two interfaces, such as OCZ's RevoDrive3 X2, available for some time, but those drives simply entail standard SATA drives in RAID and plumbed into PCIe as a workaround to the bandwidth limitations. True SATAe will be native to the interface.

There are actually early SATA Express–type drives on the market, but they are not 2.5-inch models that you can wedge into your rig. Instead, they are drives like the one featured in the new Mac Pro, which is simply listed as "next-generation PCI Express flash storage." We asked Samsung about its plans for SATA Express drives, and it pointed to the new Mac. Yes, we know it hurts. On the PC tip, Samsung has the XP941, which is a SATA Express drive that is the size of a stick of gum and offers sequential read performance of 1.4GB/s on the PCIe 2.0 interface using the M.2 form factor. All the initial SATA Express drives will use the M.2 form factor, which means SATAe will launch in notebooks first, then desktops.

When SATA Express does arrive on the desktop, it will feature a connector that is compatible with both PCIe drives and SATA drives. It's expected to first appear in Intel's Z97 core-logic chipset when its Broadwell platform debuts, hopefully sometime in 2015. It will likely scale to 8Gb/s and then 16Gb/s before being phased out for an all-new protocol dubbed Non-Volatile Memory Express (NVMe).

NVMe is designed specifically for flash-based drives in an attempt to free us from the bonds of SATA and AHCI, which were designed for rotating storage. To give you an idea of how bitchin' NVMe is, the AHCI protocol, for example, supports a queue depth of 32 commands, while NVMe supports up to 64,000. Here's another number for you to chew on: Current SATA 6Gb/s drives can hit about 85,000 IOPS doing 4K random writes. NVMe drives have demonstrated the ability to deliver 3,000,000 IOPS—though that was with DRAM instead of NAND flash in order to simulate what could happen in the future when flash speeds increase. With a NAND drive connected, it rung up over 700,000 IOPS, which is a staggering increase in performance. So, we'll be sticking with SATA 6Gb/s for 2014 on the Intel Z87 and AMD 990FX chipsets, then switching to SATA Express in 2015, then NVMe sometime after that.

Samsung's XS1715 NVMe drive is a hint of things to come, as it can read at a whopping 3GB/s with a capital B.



HARD DRIVE HAPPENINGS

If you follow the mechanical storage industry like we do, you will have noticed that the majority of the new product announcements over the past year have all involved mobile drives, cloud storage, mSATA drives, and things of that nature. The reason for this is the desktop hard drive is quickly becoming a relic of a soon-to-be-forgotten era where people stored files locally. Nowadays, people store their music, email, and even documents in the cloud, so the need for local storage is decreasing while all the growth in the sector is in solid-state and mobile. Given this state of affairs, mechanical hard drive development has mostly slowed to a crawl, with new hard drive announcements arriving about as often as a gift basket from Gordon Mah Ung. Still, development continues, of course, so we can expect some increases in capacity over the course of the next year, but since any performance gains made by rotating drives are paltry compared to what the cheapest SSD can pull off, the concept of a "performance hard drive" is already a relic, as well. Proof of this sad fact is that neither Seagate nor Western Digital even list a hard drive's spindle speed anymore, and instead just list the storage capacity, form factor, and amount of cache.

So, what do we have to look forward to on the hard-drive front? Not much, sadly. We already have 4TB, five-platter, 7,200rpm hard drives, which is enough for most people. Seagate has announced that it will deliver a 5TB hard drive in 2014 thanks to a new technology named Shingle Magnetic Recording, which overlays bits of data like shingles on a roof. The company says it expects to be at 20TB by the year 2020.

THUNDERBOLT 2: READY FOR 4K VIDEO



Thunderbolt accessories other than hard drives do indeed exist, such as this CFAST reader.

WHEN THUNDERBOLT was first introduced, we were convinced by an analyst that the spec's future was bright. Even though PC OEMs were resistant to the super-powerful-but-pricey peripheral interface, it seemed like with Apple and Intel's support, Tbolt could not fail. Today, we're not so sure where it's headed. Resistance remains among OEMs and PC hardware vendors, and with USB 3.1 on the horizon, it seems likely that Thunderbolt will be another FireWire.

Thunderbolt 2 increases the bandwidth from 10Gb/s in each of its two channels to a single 20Gb/s channel. You're probably wondering how that's so different. Previously, any given peripheral was limited to a single channel, i.e., 10Gb/s. So with video at 4K requiring slightly more than 10Gb/s, a Thunderbolt channel couldn't handle it. Now, Tbolt 2 is capable of streaming uncompressed 4K video.

More importantly: Intel has finally agreed to allow vendors to pump external video into Tbolt, so you can finally expect to see Thunderbolt and Thunderbolt 2 on systems with only discrete graphics controllers. You know, like the people who run Xeons and actually need that kind of high-speed external interface.

CHIPSETS: Z87 GETS COMFORTABLE



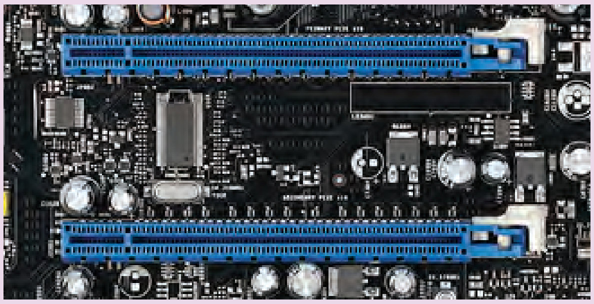
The Z87 chipset is likely to be around for quite some time in desktops.

LET'S NOT MINCE WORDS HERE: PC chipsets are going to have a pretty boring stretch for most of next year. With the fresh Z87 chipset here, Intel isn't expected to offer much in chipset-land until the end of next year. That's when the company is expected to ship its replacement for Ivy Bridge-E, called Haswell-E, with the new X99 chipset. Full details of X99 haven't been disclosed but we're guessing the chipset will bring an updated Peripheral Controller Hub, i.e., south bridge, with loads of SATA 6Gb/s ports and native USB 3.0 support. DDR4 support will also come on X99 but that's not a function of the chipset, as the memory controller is integrated into the CPU. We'd love to also see 10Gb Ethernet, but, well, that doesn't look to be happening anytime soon. Intel's mobile-focused Broadwell will likely get its own chipset that will have some compatibility with Haswell CPUs, but we're still convinced Broadwell will be mobile-only and come in BGA form. That means Broadwell will likely live only in NUC-style machines, notebooks, and all-in-one PCs.

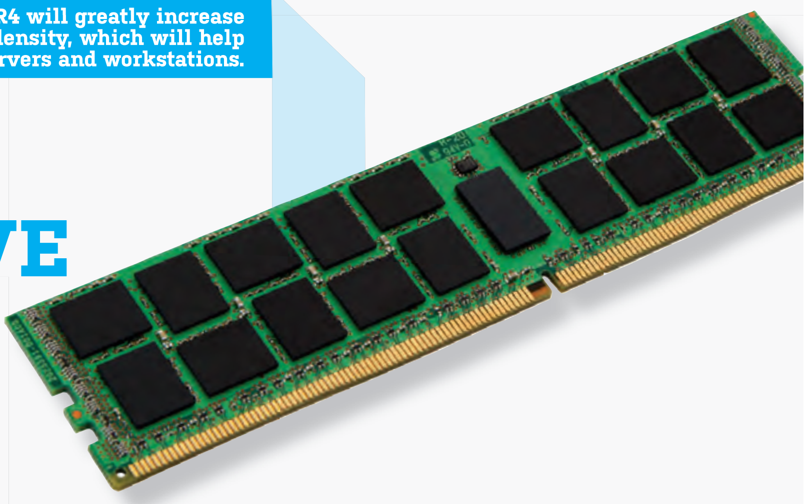
PCIE 4.0: TRUST US, WE'LL NEED IT

WHEN PEOPLE hear the words PCIe 4.0, they invariably pop off that they see no need for it because PCIe 3.0 has more than enough bandwidth. Now, pretend you're sitting in gridlocked traffic on an L.A. freeway and squawk some more about not needing more bandwidth. You build the lanes before the congestion brings the entire system to a grinding halt, capiche?

With that said, PCIe 4.0 is not a 2014 technology. In fact, we'd be surprised if we saw it in 2015—even though the spec is expected to be 90 percent done by then. PCIe 4.0 again doubles bandwidth, taking PCIe 3.0's 8Gb/s speeds to 16Gb/s. A x16 PCIe 4.0 slot on a 2015 motherboard could theoretically transfer a whopping 64GB/s. And lest you think the PCI-SIG is ceding everything to Thunderbolt (which supports the PCIe protocols), the group is working on an external PCIe spec and cable called OCuLink, with speeds supporting up to 32Gb/s in each direction.



Behold: PCIe 4.0! Actually, these are PCIe 3.0 slots, but its successor should look exactly the same.



DDR4 will greatly increase density, which will help servers and workstations.

DDR4 WILL FINALLY ARRIVE

IF NOT IN BROADWELL, THEN IN HASWELL-E

THOSE WHO CAN REMEMBER the tumultuous PC Memory Wars of '01 that raged between RDRAM and DDR should also wistfully recall how DDR's victory saw it on the quick upgrade march. After DDR's introduction in 2001, DDR2 came in 2004 and DDR3 in 2007. Since then, however, the appetite to upgrade main system RAM hasn't been there. When DDR4 finally comes out next year, we'll have been sitting with DDR3 for seven years.

DDR4 is expected to have support when Intel introduces its mobile-focused Broadwell CPUs next year. We say "expected" because there are leaks that indicate Intel may actually decide to back DDR3 with Broadwell instead.

Even if Broadwell doesn't support DDR4, we expect the new RAM to appear with the Haswell-E that's slated for the end of next year. And yes, we have faith we'll see the new CPU by then. We've actually seen prototypes of the server and desktop versions of Haswell-E, so we know the damned thing exists. What's more, Kingston showed off a server running 192GB of DDR4/2133. The company didn't say what CPU was in the box, but it wasn't hard to deduce it was Haswell-E.

DDR4 promises higher speeds, lower voltage, and greater densities over DDR3. The memory itself has been capable of being produced for more than two years, but its adoption has been stalled given the price premium and incompatibility. Since the memory controllers are directly embedded into the CPUs, Intel and AMD would have to spin new silicon to support the RAM. Both would likely have to support both DDR4 and DDR3 versions because the vast majority of computers will continue to run DDR3 due to cost.

USB 3.1 DOUBLES DOWN

10GB/S SPEEDS AND OTHER GOODIES

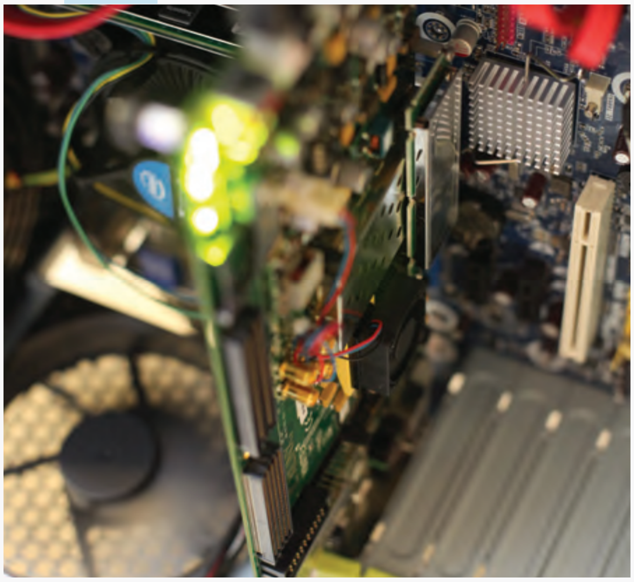
EXPECT YOUR SuperSpeed connections to get even, um, speedier next year, which is when the USB-IF is predicting the first USB 3.1 devices to emerge. USB 3.1 essentially doubles the speed of USB 3.0 from 5Gb/s to 10Gb/s while offering backward compatibility.

Since native support in Intel and AMD's chipset aren't expected immediately, motherboards and notebooks will instead integrate USB 3.1 discrete chips for support. In press demos, USB 3.1 devices are already hitting speeds in excess of 800MB/s. By the time the tech is available next fall, the USB-IF thinks speeds above 1GB/s should be attainable. Thunderbolt 2 wasn't the only connection being used to stream 4K; USB 3.1 was also demonstrated streaming 4K video—albeit compressed—using a DisplayLink connection.

That's not all. The USB-IF hopes the first devices with Power Delivery support will debut next year. USB Power Delivery devices will support universal charging through a USB port delivering up to 100 watts. In stark contrast to today's maddening array of proprietary power bricks, your next laptop could charge through a standard USB 3.1, USB 3.0, or USB 2.0 connector, much the same way you can charge your phone through any Micro USB plug (well, except for Apple's, of course.)

The USB-IF is also working on a new Media Agnostic USB (MA USB) that combines WiGig, Wi-Fi, and WiMedia Ultra-Wideband radios. MA USB is essentially a reboot of the not-so-popular Certified Wireless USB. MA USB will allow short-range wireless connectivity over everything from the 60GHz spectrum to existing 2.4GHz spectrum—all using the USB protocol.

This USB 3.1 test board is already hitting 800MB/s with 1GB/s expected by launch.





WINDOWS GOING FORWARD

CONVERGING DATA AND DEVICES

AS AN OPERATING SYSTEM running on somewhere around 90 percent of the world's desktop computers, Microsoft Windows isn't just an 800-pound gorilla. For the overwhelming majority of us, Windows *is* the computer. Microsoft sold more than 100 million copies of Windows 8 in the first six months of release, and it considers this number below expectations. Perhaps you're one of the holdouts. If so, you're probably wondering if the freshly unveiled Windows 8.1 is worth dipping your toes into, and what the future holds for this OS. And where does the company's $7.2 billion purchase of Nokia's phone division fit into this, if at all?

WHAT 8.1 IS NOT

Microsoft re-introduced a menu-like button in desktop mode, but it only returns you to the Modern interface—which you can already do by pressing the Windows key on your keyboard. But you can still get your own menu button from third parties, such as Start Menu 8 or StartIsBack. Others are just a Google search away. You can also go directly to desktop mode, but Modern retains all of its original functions.

WHAT IT IS

Windows 8.1 has boosted discoverability. The Modern interface's search function can now combine results from your local files, your "apps" (what some crusty desktop users still refer to as "programs"), and Bing, Microsoft's competitor to Google. Speaking of apps, Microsoft also says that its app store has been updated for more accurate search results, and 8.1 brings some pre-installed apps. Reading List is like a clipboard on steroids, and Windows 8.1's Photos app is supposed to have smoother editing workflow. Microsoft's SkyDrive cloud storage service is now pre-installed as the system default, and Internet Explorer 11 is also thrown in for good measure. Lastly, the update to 8.1 is free, and MS will probably stop selling the base Windows 8.0 version sometime next year, anyway.

WINDOWS 9 AND 10

Right now, we have only rumors circulating on the Internet, from people apparently outside of Microsoft. A person known only as "WZOR," on the Russian forum Ru-Board.com, has been widely reported as the source of Windows leaks for several years and has accumulated a respectable track record for accuracy. This fellow claims that we'll see Windows 9 sometime in 2014, and that it's allegedly returning to the Aero interface for desktop mode (but will presumably retain Modern alongside it).

It's unusual to have even this much information about an upcoming OS from Microsoft so far ahead of time. So there's still time for the basic elements to change, assuming that we understand them correctly. We even have some tidbits about Windows 10: It's apparently going to be cloud-oriented for apps as well as data, à la Google Docs. As computing becomes an increasingly mobile experience, it makes sense to store data at a location where it's all synced and accessible from a single service. But maintaining that kind of service costs money, eventually more than a one-time purchase of an operating system would support, even when multiplied by a hundred million purchases. A unified mobile future seems to call for a subscription-based OS—something Microsoft is already setting precedent for with Office 365.

GETTING MOBILE

That's presumably where Microsoft's purchase of Nokia's phone division fits in. Apple's iPhone experience is all under one roof, while Google has juggled dozens of different partners with varying degrees of success. Microsoft wants the minimal barriers that Apple benefits from, and it has the deep war chest for it. Rob Enderle, founder and chief analyst of Enderle Group, tells us, "The firm gives them a much more solid position as a European company, very important if you want the European Commission to see you more favorably. It assures [Microsoft] can hold on to the phone beachhead [it has] established, and it corrects inefficiencies between Microsoft and Nokia that were slowing advancement and hurting their ability to execute globally."

Overall, Microsoft looks like it's betting that the bulk of its "desktop" platform will become a mobile, always-connected future. The form factor of workstations and servers probably will not change much for the foreseeable future—but it's clear Microsoft is preparing for a future where the desktop looks like it will shrink dramatically, or be more frequently replaced with a laptop.



In Windows 8.1, the Modern interface allows higher tile density and the ability to select tiles by group.



GAMING ON THE

BY TOM MCNAMARA AND JIMMY THANG



E GO

FOUR PORTABLE GAMING NOTEBOOKS SQUARE OFF



Back in the day, to get any real power in a notebook, you needed to have a massive chassis to house all the most beefy mobile components. But today, with Intel's smaller, more power-efficient Haswell processor and shrinking mobile video cards, this is no longer the case. The advent of these new parts means it's now possible to get serious performance without sacrificing portability, hence the growing number of capable gaming notebooks measuring 15 inches or less. The trouble is, with so many portable gaming options, which one do you choose?

In an attempt to answer that question, we've rounded up four of the more portable gaming laptops we could find: the 15.6-inch Lenovo Y510p, the 15.6-inch Eurocom X3, the 14-inch Alienware 14, and the 13.3-inch Digital Storm Veloce. We're also throwing in the CyberPower Zeus Hercules, which features Intel's Iris Pro, to see how a gaming laptop with modern, high-end integrated graphics stacks up against the discrete-graphics competition. Which gaming notebook is for you? Read on to find out!

LENOVO IDEAPAD Y510P

A good idea, but a flawed IdeaPad



Lenovo really needs to add dedicated buttons to the trackpad.

WHEN WE FIRST reviewed the Lenovo Y500 back in our July 2013 issue, we praised it for being an amazing value. Though it wasn't a perfect gaming notebook, it did come with two GeForce GT 650Ms, 16GB of RAM, and 1TB of storage for a modest $1,250, which was such an awesome deal that we placed the notebook atop our esteemed Best of the Best list. Fast forward a few months and Lenovo has refreshed the notebook with a new Haswell CPU as well as a pair of beefier GeForce 700-series cards. This new IdeaPad has been rechristened the Y510p, and retails for a fair amount more than its predecessor, at $1,600. The question on our minds, of course, is whether the Y510p provides the same great value.

Despite its new moniker, the laptop comes with the same chassis as the Y500—a 15.2x10.2x1.4-inch brushed-aluminum enclosure adorned with a bold, red-LED-backlit keyboard that is flashy without being gaudy. It weighs in at a reasonable six pounds, 6.6 ounces—roughly the same as the smaller Alienware 14, although its carry weight is dragged down by a bulky two-pound power brick. It's worth noting that despite the Y510p's fairly thin profile for a 15.6-inch gaming laptop, we never heard its fans spinning loudly.

The Y510p's 1920x1080 monitor offers a very bright and competent display for a TN panel, but it falls a bit short when compared to the IPS screens in the Alienware 14 and Digital Storm Veloce, which provide much greater viewing angles. Conversely, unlike those two smaller laptops, the Y510p provides a full-size keyboard with number pad, complete with chiclet keys that are quiet and feel good to type on. On the audio front, the Y510p uses the same JBL speakers we know and love; they have plenty of firepower and make everything sound clear. Sadly, the laptop retained the same frustrating trackpad as its predecessor, with integrated mouse buttons. Coupled with the trackpad's oversensitivity, the indistinct buttons often had us making small, accidental swipes whenever we tried clicking links.

Another disappointment is that the Y500's unique, expandable drive bay, which allowed you to swap in a second GPU, fan, HDD, or optical drive, has been neutered to only allow a second, removable GPU, which is the stock configuration.

Fortunately, that configuration consists of two GeForce GT 750GB GPUs in SLI. CPU-side, our Y510p came outfitted with a Haswell-based Core i7-4702MQ processor clocked at 2.2 GHz, and 16GB of RAM. For storage, our configuration came with a 16GB mSATA caching SSD anchored by a 5,400rpm 1TB HDD.

Putting these specs through our barrage of benchmarks, the Y510p produced some mixed results. Its dual–video card setup gave our MSI GT60 zero-point laptop a smack across the face with a 74 percent gain in 3DMark 11, and it even bested both the Alienware 14's and Digital Storm Veloce's GTX 765M configs by roughly 10fps across all of our game benchmarks. In the CPU-intensive benchmarks, however, the Y510p fell short. Even our ZP's Ivy Bridge part was able to trade blows with it. In terms of battery life, the Y510p got hammered, lasting only 154 minutes in our video-rundown test. It turns out that SLI setups don't support integrated graphics through Nvidia Optimus, so we had to remove the second video card—which requires shutting down, removing the battery, and ejecting the second video card—to bolster the Y510p's battery life to 195 minutes.

We would be inclined to dismiss the Y510p's shortcomings if it still came at the same great price as the Y500, but it's over $300 more for not much extra performance. Luckily, multiple configurations are available, so if you want a good IdeaPad, it's probably best to customize the Y510p to fit your needs.

SPECIFICATIONS

CPU	2.2GHz Intel Core i7-4702MQ
RAM	16GB DDR3/1600
Chipset	Intel HM78
GPU	2x Nvidia GeForce GT 750Ms in SLI
Display	15.6-inch, 1920x1080 LCD (matte)
Storage	16GB mSATA SSD, 1TB hard drive (5,400rpm)
Connectivity	Ethernet, VGA, HDMI, 2x USB 3.0, 1x USB 2.0, audio in, headphone, mic, 1MP webcam, built-in Bluetooth, 802.11n
Lap / Carry	6 lbs, 6.6 oz / 8 lbs, 1.7 oz

VERDICT 8

Lenovo IdeaPad Y510p

$1,600, www.lenovo.com



EUROCOM X3

Don't judge a gaming notebook by its cover

In between the trackpad's buttons is a fingerprint scanner.

THE EUROCOM X3 might look familiar, as it uses a Clevo chassis that's similar to the Eurocom Scorpius we reviewed in our March 2013 issue, sharing the same dull-looking, black, boxy design. But there are some key distinctions, with the biggest difference being its smaller size. At 15x10.7x1.8-inches, the X3 features a 15.6-inch screen compared to the Scorpius's 17.3-inch screen, and weighs seven pounds, 10.4 ounces, which is about three ounces lighter than our 15.6-inch MSI GT60 zero-point laptop. It won't break your back, but you won't want to lug it in your backpack all day.

The X3 uses a matte TN panel for its display that features decent viewing angles but still can't compete with the Alienware 14's and Digital Storm Veloce's IPS offerings. In addition, compared to the other notebooks in this roundup, we noticed a more ruddy cast to the X3's screen, lending people a sunburned-looking appearance. Considering that our particular configuration costs $3,300, it's a shame an IPS panel, which can offer more accurate colors, wasn't included.

On the plus side, we didn't have any issues with the full-size keyboard, which, like the Lenovo Y510p's, was quiet, easy to type on, and includes a numpad. Unfortunately, also like the Y510p, we weren't super enamored with the trackpad. Although it's light years better than the Scorpius's trackpad before it, you'll definitely want to tweak the sensitivity settings. The trackpad also supports two-finger scrolling, though it often couldn't tell if we were trying to scroll down a page or pinching to zoom. Another gripe we have is that the speakers are a little underwhelming. While it comes with a built-in subwoofer underneath the chassis, the X3 doesn't have the greatest volume firepower and can easily get drowned out in a noisy room.

So far, the X3 probably sounds like it's not worth its high asking price, but it's redeemed by what it has going on under the hood. This bad boy is equipped with a Core i7-4930MX Extreme Edition chip clocked at 3GHz with a Turbo Boost of 3.9GHz, 16GB of RAM, and Nvidia's new, leading laptop GPU, the GeForce GTX 780M. All in all, it's got enough juice to make Tim the Toolman howl. Our only real complaint with the specs concerns the SSD. The included 128GB storage isn't necessarily small, but for the price, we'd expect a 256GB drive. Even the much more affordable Alienware 14 in this roundup includes one.

That quibble aside, the X3 managed to slaughter every gaming laptop in this roundup. As a matter of fact, Eurocom's laptop won in every single performance benchmark by significant margins, be it in the CPU-intensive applications or, more punishingly, games. Its only performance shortcoming came in the battery test, where it lasted a mere 167 minutes, shy even of our Ivy Bridge zero-point system's score. Unfortunately, with great power comes great battery loss.

When you take into consideration that the X3 costs twice as much as both the Lenovo Y510p and the Digital Storm Veloce, it should come as no surprise that Eurocom's notebook mops the floor with them all. It's only disappointing that it has to make some compromises along the way.

SPECIFICATIONS

CPU	3GHz Intel Core i7-4930MX
RAM	16GB DDR3/1600
Chipset	Intel HM78
GPU	Nvidia GeForce GTX 780M
Display	15.6-inch, 1920x1080 LCD (matte)
Storage	128GB SSD, 1TB hard drive (7,200rpm)
Connectivity	Ethernet, HDMI, 2x USB 3.0, 1x USB 2.0, S/PDIF, headphone, mic, line-in, 2MP webcam, built-in Bluetooth, 802.11n, DisplayPort 1.2, Mini Display 1.2, 1x eSATA, FireWire-400
Lap / Carry	7 lbs, 10.4 oz / 9 lbs, 13.4 oz

VERDICT 8

Eurocom X3

$3,300, www.eurocom.com



ALIENWARE 14

Beauty has a price

The bezel around this 14-inch screen is pretty sizable, but it doesn't stand out when you're using it.

WITH COMPUTING becoming more mobile every day, system builders like Alienware are eager to cram a lot of gaming performance into portable packages. Simply branded as the Alienware 14 in reference to the size of the screen, this new laptop sets out to replace the company's long-running M14x line. While Alienware could have rested on its laurels, this is much more than a simple refresh.

For one, the 14 looks much bulkier than its predecessor, to the point where one wonders about its portability. While it actually weighs slightly less than the M14x, it still doesn't feel like the kind of laptop you could throw in your bag and lug around town, unless you know a good chiropractor. That said, the build quality feels very solid. The matte-black chassis and its silver aluminum top might not stop a speeding bullet, but it should handle getting knocked around a little.

The illuminated touchpad is also pretty sweet. You don't realize how handy the boundary detection is until you try using it in the dark. But those aren't the only LED lights on the notebook. The Alienware 14 also features a backlit keyboard, glowing logos, and sundry beams of light strewn around the chassis. All of these are controlled with the company's AlienFX utility, which allows you to use presets or customize the colors to your heart's content. Speaking of visual details, the IPS screen also delivers excellent viewing angles. The matte screen takes care of glare without looking grainy or sparkly.

In terms of GPU, the Alienware 14's Nvidia GTX 765M is nothing to sneeze at. In our tests, using the system's pre-installed 326.33 beta drivers, we averaged over 30fps in Tomb Raider at 1080p with everything enabled except TressFX. BioShock Infinite nearly hit that mark as well, maxed out at 1080p. While playing Borderlands 2, we saw a reliable 45–60fps, with ambient occlusion disabled. The 765M has 2GB of RAM and its internal design is closest to the desktop GTX 650 Ti. This laptop should have no problem sustaining playable frame rates and high image quality in the latest games. It also exhausts heat out the back, which helps mask fan noise. In terms of ports, the 14 puts almost all of its connectors on the left-hand side; the right side gets Ethernet, a spare USB 3.0 port, the Blu-ray slot loader, and a media card slot.

The $1,900 price tag for this unit doesn't provide the greatest value, however. For a mid-tier configuration that's roughly $500 less, you can trade the Blu-ray unit for a DVD burner, 802.11ac for 802.11n, 16GB of system RAM for 8GB (still plenty for games), and opt for the caching SSD. Unfortunately, there's no dual-GPU option, or anything beefier than a 765M. Alienware reserves such luxuries for its 17- and 18-inch models. Meanwhile, the Lenovo unit we tested this month comes with dual 750Ms and easily beats the 14 in every game, while costing about $300 less (albeit with its own set of compromises). Another gripe we have is that we had to reboot the computer whenever we wanted to switch between integrated and discrete graphics.

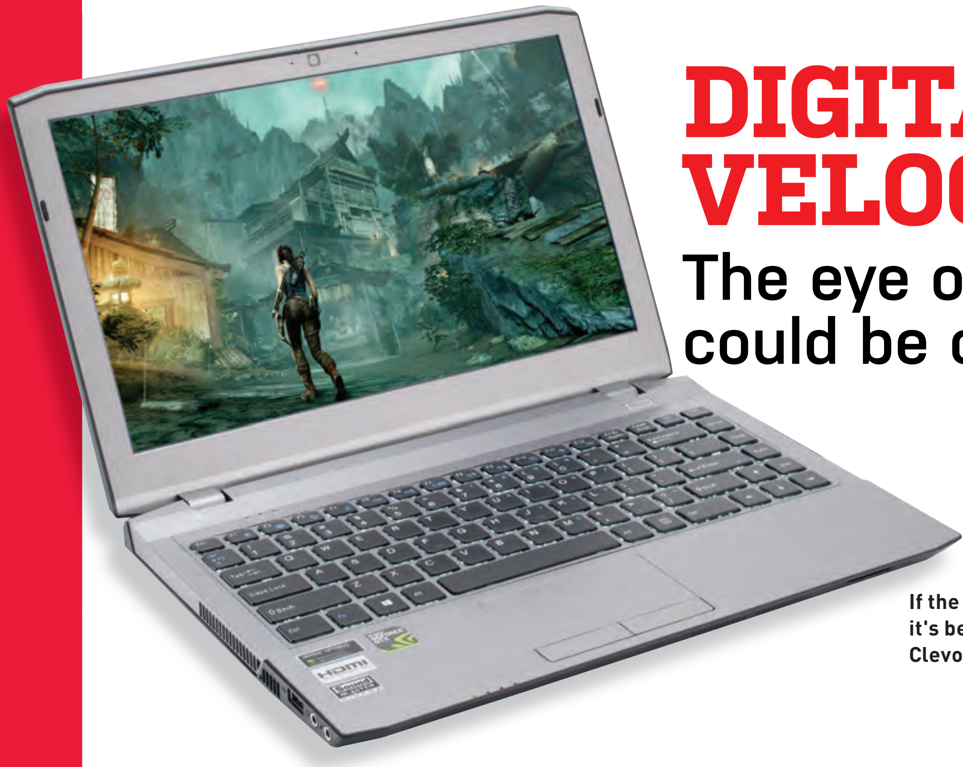
SPECIFICATIONS

CPU	2.4GHz Intel Core i7-4700MQ
RAM	16GB DDR3/1600
Chipset	Intel HM87
GPU	Nvidia GTX 765M
Display	14-inch, 1920x1080 IPS display (matte)
Storage	256GB mSATA SSD, 750GB 5,400rpm HDD
Optical Drive	Slot-loading dual-layer Blu-ray reader
Connectivity	HDMI, Mini DisplayPort, 3x USB 3.0, audio in, microphone, headset, 2MP webcam, built-in Bluetooth, Broadcom Wireless-AC 2x2, Gigabit Ethernet, 7-in-1 media card reader
Lap / Carry	6 lbs, 6.4 oz/ 7 lbs, 13.6 oz

VERDICT 8

Alienware 14

$1,900, www.alienware.com



DIGITAL STORM VELOCE

The eye of this storm could be calmer

If the Veloce looks familiar, it's because it uses the Clevo W230ST chassis.

SINCE MANKIND descended from the trees, we have struggled to combine the portability of a laptop with the performance demands of PC gaming. Sacrifices are inevitable. The Veloce crams an Nvidia GTX 765M into a notebook with a small 13.3-inch screen, which not too long ago would have qualified it for netbook dimensions. How does it manage? Not entirely well.

But let's start with the basics. The Veloce has Intel's shiny new Haswell mobile CPU, which is purported to bring much-improved battery life over Ivy Bridge–based systems. It also gets an IPS panel, so you don't have to fiddle with your eye level when you open the thing up. The keyboard is backlit with a gentle white glow, and the keys have a little spacing to prevent mis-types. Under the hood, you get a respectable 8GB of system RAM, a 128GB mSATA drive, and a 750GB 5,400rpm drive.

Its 765M averaged a little under 30fps in Tomb Raider, at 1080p with everything but TressFX enabled. We found that during our experiential play test, turning off tessellation and depth-of-field roughly doubled performance, without much of a hit to image quality.

SPECIFICATIONS

CPU	2.7GHz Intel Core i7-4800MQ
RAM	8GB DDR3/1600
Chipset	Intel HM87
GPU	Nvidia GTX 765M
Display	13.3-inch, 1920x1080 IPS display (semi-gloss)
Storage	128GB mSATA SSD, 750GB 5,400rpm HDD
Optical Drive	Not included
Connectivity	HDMI, VGA, 3x USB 3.0, USB 2.0, audio in, microphone, 2MP webcam, built-in Bluetooth, Intel Wireless-AC 7260, Gigabit Ethernet, 6-in-1 media card reader
Lap / Carry	4 lbs, 4.4 oz/ 5 lbs, 12.8 oz

The Veloce's exterior doesn't fare so well. Specifically, the keyboard area flexes a little as you type, especially in the middle. Right above the keyboard is an embedded plastic strip that wasn't quite flush against the surface. It's minor, but enough to mar our overall impression. The rubberized lid also smudges easily.

The ergonomics are also kind of disappointing, at least considering the $1,600 price tag. Almost all the external connectors are on the right-hand side, which is where right-handed people will be using their mouse. The left-hand side has only a headphone jack, mic jack, and a single USB 2.0 port. Meanwhile, USB 3.0, HDMI, VGA, and the AC power input make it awfully crowded on the other side of the table, unless you're primarily using the touchpad. But since the Veloce is billed as a gaming laptop, that scenario doesn't seem likely. Also, the fans frequently cranked up for 10–20 seconds when the system was idle or minimally loaded. It's distracting if you're just trying to watch a YouTube video or write an email. The system also uses the left-hand side to exhaust heat, unlike the Alienware 14 which pushes heat through the back; this means the fan noise can get pretty grating. One of the fans also rattled occasionally, sounding like a mechanical hard drive moving data around.

While the Veloce is definitely the thinnest and lightest notebook in this roundup, it may have too much power for its own good. Unfortunately, this meant the battery wasn't able to last that much longer than the zero-point MSI GT60, even with the more power-efficient CPU. If you don't mind a heavier laptop, the Alienware 14 can be configured with mostly the same specs for not too much more while yielding better durability and less noise.

VERDICT 7

Digital Storm Veloce

$1,600, www.digitalstormonline.com



GOOD BUT NOT GREAT

If only we could take the best parts of all these rigs and roll them into one

WE WISH WE could declare a clear winner in this roundup—one that offers the complete package of performance and portability, but unfortunately, each notebook has different strengths and weaknesses, and none comes out as being particularly impressive.

Sure, the Eurocom X3 mopped the floor with the others in the performance benchmarks, but it's also the most expensive laptop by a long shot, offers weak battery life, is the heaviest, and features an unimpressive TN panel. On the flipside, the Lenovo Y510p is much more affordable and bests both the Alienware 14 and Veloce in the graphics department with its SLI setup. But it has a relatively lackluster CPU, a frustrating trackpad, and also goes the less-than-desirable TN route. While the highly portable Veloce is equally affordable to the Y510p despite an upgrade to an IPS panel and offers impressive performance for its size, its build quality feels cheap and its fans are annoyingly loud. Then there's the Alienware 14, which has the best battery life out of the bunch, offers the slickest aesthetics, but is on the pricey side and its overall performance is a bit lacking.

These are all respectable products, but it looks like the gaming laptop mountain doesn't have a king just yet.

GAMING LAPTOPS COMPARED

	MSI GT60 (zero point)	Lenovo Y510p	Eurocom X3	Alienware 14	Digital Storm Veloce
Stitch.Efx 2.0 (sec)	1,092	1,118	**856**	962	981
ProShow Producer 5 (sec)	1,786	1,769	**1,509**	1,629	1,576
x264 HD 5.0 (fps)	12	9.7	**14.9**	13.5	12.8
STALKER: CoP (fps)	32.8	40.8	**89.1**	40.7	39.3
3DMark 11 Perf	2,979	5,194	**7,967**	4,170	4,319
Tomb Raider (fps)	N/A	45.3	**69.8**	32.6	34.1
Hitman: Absolution (fps)	N/A	24.3	**35.6**	14.3	14.9
BioShock Infinite (fps)	N/A	39.7	**58.6**	28.1	29.2
Battery (min)	187	154	167	**234**	195

Best scores are bolded. Our zero-point notebook is an MSI GT60 with a 2.3GHz Intel Core i7-3610QM, 12GB DDR3/1600, two 500GB Seagate 7,200rpm hard drives, a GeForce GTX 670M, and Windows 7 Home Premium 64-bit. STALKER CoP tested at 1920x1080 with Ultra settings, Tessellation, and contact hardening. N/A denotes that benchmarks were not run on the zero point.

REDEFINING 'GOOD ENOUGH' GRAPHICS

Intel's Iris Pro integrated graphics steps it up

WE'VE LONG used the analogy that if Intel is Lucy and integrated graphics is the gaming-capable football, we're all Charlie Brown. Yup, that bald-headed kid who just keeps thinking that every time Intel says its integrated graphics are capable of playing games, we believe it and throw our back out trying to kick that football to the moon. Well, listen up, blockhead: Lucy is in front of you once again, dangling that pigskin, and this time, she's really serious that she'll let you kick it.

To find out if that football will stay in place or be snatched away again, we took CyberPower's new Zeus Hercules—a $1,300, 14-inch portable equipped with an Intel Core i7-4750HQ and its highest-end Iris Pro 5200 graphics with embedded DRAM—and benched it against an Ivy Bridge graphics–equipped HP Spectre Ultrabook, as well as an older Acer Timeline M3 Ultrabook. The Timeline M3 has an aged 32nm Sandy Bridge CPU but it also has an Nvidia GeForce GT 640M discrete card on board.

The results? First off, the Intel HD4000 graphics in the HP Spectre are not even in the running. We'll remind you that when Ivy Bridge came out, ol' Lucy touted *its* graphics as being substantially improved. Um, yeah.

Against the GeForce GT 640M, the Iris Pro 5200 proved surprisingly comparable in most of our tests. When it was introduced, Nvidia said the GeForce GT 640M was capable of playing Battlefield 3 at Ultra—quite a feat in 2012 (of course, playing at Ultra meant settling for less than 30fps). Still, that Intel's Iris Pro 5200 integrated graphics can offer performance close to or better than that discrete part is finally proof that Intel won't always pull that football out from under our feet.

Of course, looked at another way, the GeForce GT 640M is a pretty old GPU at this point. We believe current midrange discrete graphics would easily step away from Iris Pro 5200. However, Iris Pro 5200 is actually capable of playing a lot of games at 1366x766 resolution with very satisfactory frame rates. In addition to our benchmarks, we played Call of Duty: Black Ops 2, Left 4 Dead 2, and Minecraft with no complaints. Moving up to Battlefield 3, we had to turn down the settings a few notches, but the playability was far better than we've ever before experienced with integrated graphics.

One other performance metric we looked at was OpenCL computing. Since the Iris Pro 5200 features that massive 128MB of L4 cache we've been chattering about since Haswell launched (Intel, give us a socketed version, please), we wanted to see if the top-end IGP has it where it counts in compute. It does. It destroyed the Spectre's HD4000 graphics in the OpenCL benchmarks we ran and came pretty close to the GeForce GT 640M in the OpenCL 1.1.3 benchmark. In LuxMark 2.0, it crushed both the HD4000 and the discrete part.

There are two things to take away from this: The first is that the high-end discrete GPU has absolutely nothing to fear from Iris Pro 5200—we didn't even bother to compare it to the gaming notebooks in this roundup because it would be embarrassing for integrated graphics. They're that much faster in gaming. The second is that for a lot of people who just want a "normal" notebook, the Iris Pro 5200 is good enough, and a hell of a lot better than anything that has come before. Let's just say the next time Lucy approaches us with that football, we may not be so cynical.

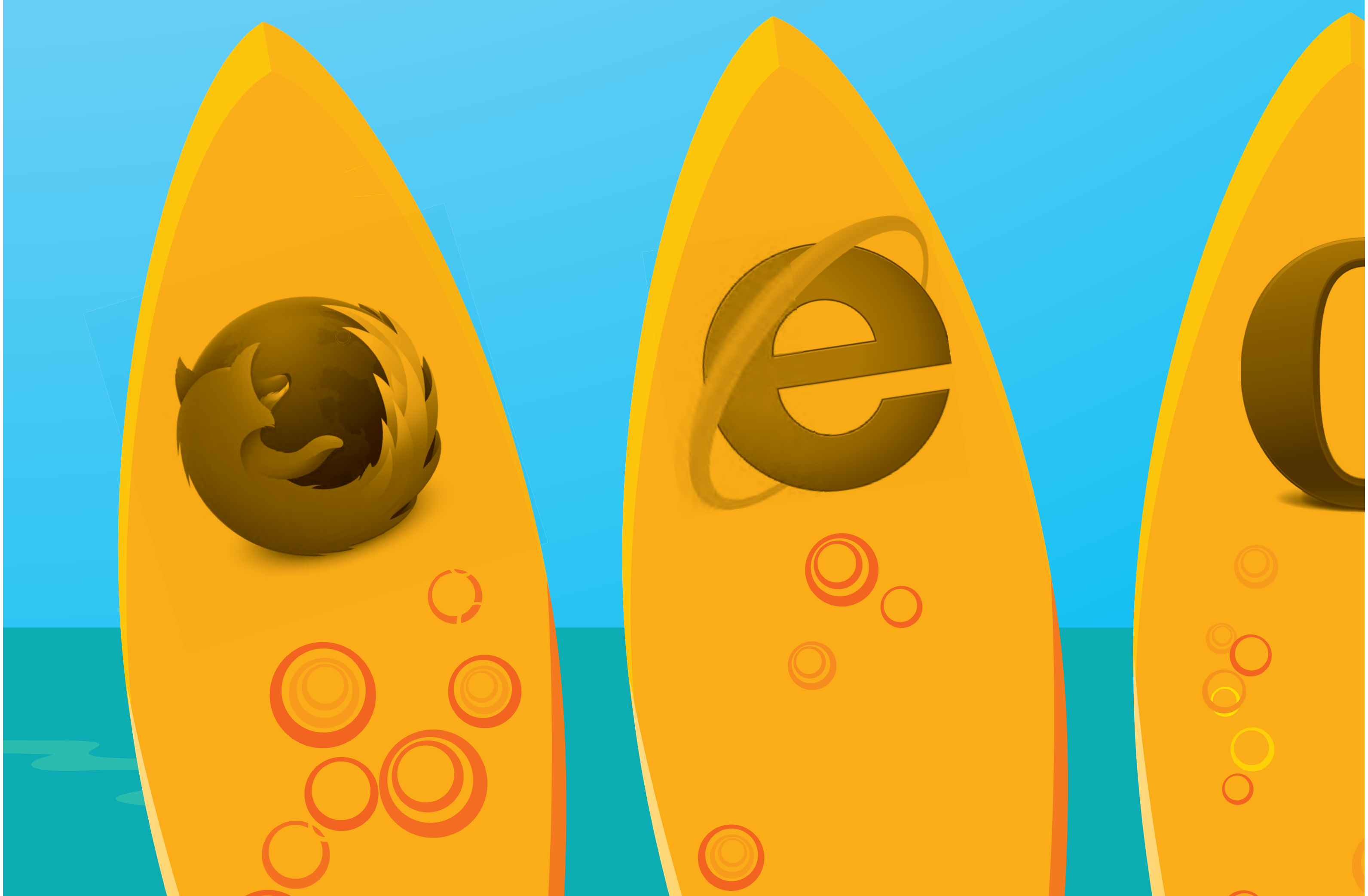
–GORDON MAH UNG

BENCHMARKS

	CyberPower Zeus Hercules	Acer Timeline M3	HP Spectre
GPU	Intel Iris Pro 5200	Nvidia GeForce GT 640M	Intel HD4000
CPU	Core i7-4750HQ	Core i7-2637	Core i7-3517U
3DMark 11 Extreme Overall	**X637**	X607	X210
3DMark 11 Extreme Graphics	**568**	544	188
3DMark 11 Performance Overall	**P2,054**	P1,840	P611
3DMark 11 Performance Graphics	**1,811**	1,750	532
3DMark New Firestrike Overall	**1,310**	1,213	512
3DMark New Firestrike Graphics	**1,310**	1,297	544
3DMark New Cloudgate Overall	**9,513**	5,248	3,302
3DMark New Cloudgate Graphics	**11,585**	9,044	4,344
3DMark Ice Storm Extreme Overall	52,958	**55,600**	30,406
3DMark Ice Storm Extreme Graphics	60,474	**84,990**	35,192
Unigine 4.0 13x6 (fps)	22.3	**24.9**	7.7
STALKER: CoP Day (fps)	56.3	**67.8**	21.7
STALKER: CoP Night (fps)	63.2	**70.1**	19
STALKER: CoP Rain (fps)	70.1	**74.1**	22.4
STALKER: CoP Sun Shafts (fps)	43.8	**44.8**	13.7
OpenCL 1.1.3 Physics: SPH Fluid Simulation	1,434	**1,515**	525
OpenCL 1.1.3 Vision: Optical Flow	1,389	**1,649**	302
LuxMark 2.0 Sala (score)	**462**	101	67
LuxMark 2.0 Room (score)	**325**	47	33

Best scores are bolded.

SURF WARS: FIVE WEB BROWSERS COMPARED



A FEROCIOUS FREE-FOR-ALL AMONG THE WEB'S TOP BROWSERS

BY PAUL LILLY

The landscape is evolving and you can either change with it or be left behind. This is the position browser makers find themselves in as cloud computing and touch interfaces take center stage, as Windows 8 with its vastly overhauled UI continues to wiggle into more homes and businesses around the world, and as web developers push increasing amounts of rich content at site visitors.

Assuming all browsers handle online content reasonably well, you might be asking yourself why your choice of browser matters, since they're all free to use. Don't sell yourself short—you and every other computer user with an Internet connection matters to browser makers. More than just having an effect on your personal online experience, the browser you select is essentially a vote in favor of which company wields the most control over emerging and evolving web standards, which itself directly impacts how you see and experience the web.

Secondly, there are advertising dollars at stake. The majority of Mozilla's funding for Firefox comes from Google, which pays the open source browser maker an obscene amount of cash (around $300 million annually) to have its search engine the default option.

There's a lot at stake, and on the following pages, we'll weigh in on each browser's strengths and weaknesses. When evaluating a browser, we look for standout features, security protocols, privacy options, and raw speed. The stage is set, but which will emerge the victor: Internet Explorer, Firefox, Chrome, Safari, or Opera?



MOZILLA FIREFOX 23

FAST AND NIMBLE, BUT NO LONGER THE PACK LEADER

In the little more than two years that elapsed since our last major browser brouhaha, Mozilla has taken Firefox from version 4 all the way to version 23, which itself is likely to be a version or two behind by the time you read this. That's because Mozilla adopted a rapid release schedule that sees a new build around every 6 weeks. Mozilla felt pressured to keep up with fast evolving web standards like HTML5 and decided it was best to push out new features as quickly as possible. As a result, Firefox never gets outdated, though new builds end up feeling more like micro-updates rather than major revisions.

WHAT'S NEW

If we focus solely on Firefox 23, there's not a lot that's new compared to the previous release. Mozilla removed some of the shine from the logo, added a button to the toolbar to share websites with participating social networks like Facebook, and beefed up security. Over the course of the last several releases, however, Firefox added a built-in PDF reader, gained a social API, added support for Retina displays on Mac OS X 10.7 and up, and made a few other tweaks. Somewhere along the line, Mozilla finally managed to plug the infamous memory leak issue that plagued earlier versions.

SECURITY

Mozilla diligently patches security holes in each new release. In Firefox 23, Mozilla shored up its browser's defenses by injecting a mixed-content blocking mechanism. When a secure HTTPS page loads non-secure, unencrypted content over HTTP (known as mixed content), you're susceptible to man-in-the-middle attacks. Mozilla's mixed-content blocker doesn't let non-secure, active content through by default, thereby providing a layer of protection against these attacks. Cool, right?

What's not so cool is that Mozilla made it unnecessarily difficult to disable JavaScript by removing the option from the Contents tab in the Options menu. To flip the switch, you either have to install a third-party extension or poke around about:config settings.

PRIVACY

One feature we hoped Firefox would have added by now is turning on the Do Not Track (DNT) setting by default. Much to the chagrin of advertisers who serve up tracking cookies, Mozilla has long planned to do this, but it keeps getting delayed for one reason or another. Still, it's there as an option, and so is the infamous private-browsing, which lets you surf the web without leaving any trace of your whereabouts once you close the browser.

PERFORMANCE

Firefox 23 flexes a fair amount of web-rendering muscle, but it no longer has the quickest draw of the bunch. Out of the five browsers tested, Firefox 23 came in third in its own Kraken JavaScript benchmark, losing to Chrome and Opera. Not by much, mind you, but losing on its home turf underscores the changing of the guard that's taken place since our last browser roundup (June 2011).

POWER-USER TIPS

1. Since it's not enabled by default, manually turn on Firefox's Do Not Track feature by clicking on the Firefox menu and navigating to Options > Options > Privacy. Select the radio button that reads, "Tell sites that I do not want to be tracked."

2. To disable JavaScript, type **about:config** in the URL bar. Find javascript.enabled, right-click, and select Toggle to change the value to False.

3. Need more real estate? Click Firefox > Options > Toolbar layout and check "Use Small Icons."

OPERA 15

IF YOU CAN'T BEAT 'EM, JOIN 'EM

For years, Opera's development team championed strict web standards through their own rendering engine called Presto. Maintaining a relevant rendering engine is a massive undertaking, so for version 15, Opera Software made the decision to swap out Presto for Google's Blink engine, which is a fork of Webkit and the same one driving Chrome. It's a significant change and one that allows the Norwegian browser maker's small team to narrow their focus on Opera's complementary features and security.

WHAT'S NEW

A new rendering engine is just one of the many changes in Opera 15, not all of them positive. Bookmarks have vanished (Opera Software plans to return them in a future release), and the integrated M2 email and news client played a disappearing act just like Presto. In their place is an overhauled UI that more closely resembles Chrome, along with a combined address and search bar.

Opera's Speed Dial feature lists thumbnails of saved web pages on new tab windows, and new to Opera 15 is the ability to group and search entries. Also new are Stash and Discover entries in new tab windows. When you click the heart icon in the address bar, Stash will take a snapshot of the website, while Discover lists news clips from around the web.

Finally, Opera 15 introduces an Off-Road mode that adopts server-side compression technology found in Opera Mobile.

SECURITY

By making the transition to Blink, Opera 15 becomes the beneficiary of security protocols included in the Chromium project, such as running tabs in separate processes and sandboxing. Opera also adopts a rapid release schedule for more frequent security updates, both as it pertains to Blink as well as parts of the browser not related to Chromium (everything but the engine).

PRIVACY

Opera 15 retains the ability to open a private-browsing window, which you can run alongside a non-private session. The feature is more easily accessible in Opera's main drop-down menu. Opera 15 also supports Do Not Track

1) New to Firefox 23, you can now share websites on Facebook by clicking a button in the toolbar. Other social sites plan to integrate this function, too.

2) To poke your head underneath the hood, type about:config in the URL bar and explore the underlying parts. Be careful though, changing settings can bork your browser.

3) Other than the optional sidebar, Firefox 23 is virtually identical in appearance to Firefox 4 from two years ago. Now that Windows 8 is here, we suspect Mozilla will tweak the UI for touch navigation.

4) Whoops, did you accidentally close a tab? Bring it right back by pressing Ctrl+Shift+T. If you want even more control over tabs, hunt down the Tab Mix Plus add-on.

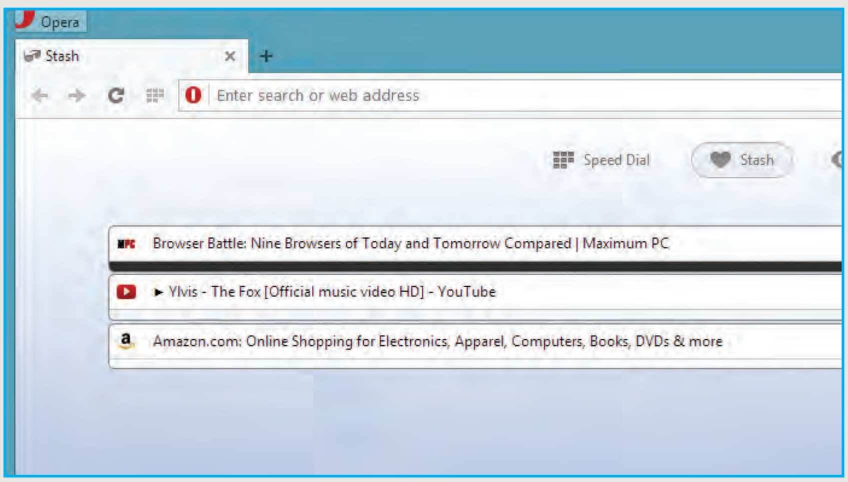


VERDICT 8

requests, though the feature is turned off by default.

PERFORMANCE

The Blink rendering engine gives Opera an instant speed boost that puts the browser nearly on par with Chrome. In our benchmark tests, Chrome 29 still edged out Opera 15 in most tests, though Opera was faster in Microsoft's Lawn Mark 2013 test. Furthermore, neither browser ever left the other one in the dust. That's an impressive testament to Opera's upgraded code, since Chrome ended up being the fastest of the bunch.



VERDICT 7

Opera 15 does away with traditional bookmarks, but you can "Stash" websites with screenshot previews that appear on the Start page and new tab windows.

CHROME 29

ALL HAIL THE NEW KING

Chrome recently celebrated its fifth birthday, and though it required a few coats of polish to really shine, most users today couldn't or wouldn't want to fathom a world without Google's quick and nimble browser. To wit, Chrome did what no other browser could do—it dethroned Internet Explorer in market share, at least according to StatCounter's data. NetMarket-Share still has IE in the lead, but the mere fact that Chrome is even in the discussion is a remarkable achievement for such a young browser.

WHAT'S NEW

Google decided early on that a rapid release schedule made the most sense, so like Firefox, individual updates typically lack hordes of killer features to make you pump your fist in excitement. Over time, however, the experience gradually changes. In Chrome 29, Google added an immersive mode that hides the toolbar and shelf in full-screen mode until you hover over the top. There's also a "Reset browser settings" to restore Chrome to its original state. If you're in love with Windows 8's touch-friendly interface, you'll also adore running Chrome in Windows 8 Mode, which replaces IE as the default browser in the process.

SECURITY

Chrome 29 came with more than two dozen security patches, an unusually large amount. Part of the reason is because Google routinely rewards external security researchers with financial bounties for discovering bugs. Combined with Chrome's automatic updates and sandbox approach to browsing, you're about as protected as you can get outside of a virtual machine.

PRIVACY

Up until version 23, one of the few criticisms you could make about Chrome was that it didn't have a Do Not Track feature like IE and Firefox. Google took its sweet time adding DNT code to Chrome, but it's there, only you have to hunt down the setting and manually turn it on just like in Firefox. Even when you do, the effectiveness of DNT hinges on whether websites honor your request or essentially tell you to go fly a kite.

For browsing on the sly, Chrome's Incognito mode erases the past more efficiently than Stephen King's Langoliers.

PERFORMANCE

Even Michael Jordan didn't win every game he played in, and though it wasn't a clean sweep for Chrome either, Google's browser had the best score in more benchmarks than any of the other four contenders in this roundup. And unlike in our browser cage fight from two years ago, Chrome now boasts hardware acceleration.

POWER-USER TIPS

1. Install the Omnibox Timer extension to set reminders in the Omnibar while you're at your PC. Once installed, activate a timer by typing **TM** in the Omnibar and then something like, "15 stand up and take a break" to be reminded in 15 minutes to move around. (Protip: Sitting for long stretches is bad for your health.)

2. Google isn't your only search option in Chrome. Type **Amazon** in the Omnibar followed by the Tab key and then type in your search query. You'll see the option to bring up search when you start typing in websites you've previously visited. Alternately, type the name of a site followed by a colon and then your search query (e.g., **MaximumPC: Intel**).

3. Fancy yourself a code junkie? Right-click a website and select "Inspect element" to spy a site's code.

SAFARI 5.1.7

APPLE ABANDONED IT, AND SO SHOULD YOU

The last time Apple updated its Safari browser for Windows desktops was in May 2012, and that was just a minor house-keeping patch. Apple left Windows users behind when it introduced Safari 6 for Mac OS X 10.8 Mountain Lion, and while the Cupertino outfit hasn't explicitly stated Safari will never make a return to Microsoft's OS, there's little reason to believe it will. Safari was never able to carve out a significant share of the browser market anyhow, though both NetMarketShare and StatCounter agree that there are more web surfers on Safari than Opera, so leaving Windows users behind might not have been the best long-term decision.

WHAT'S NEW

Though Apple has turned a blind eye to Windows users, the latest version of Safari is still available to download. Prior to abandonment, Safari's Reading List feature alone was reason to consider the browser. What it does is let you save web pages you don't have time to read and return to them later, online or offline. Think of it as a temporary bookmarks feature that self-destructs once you've brought up a saved page.

Safari Reader is another element of the browser we liked. It strips web pages to the bare essentials, removing most ads and preventing pop-ups.

SECURITY

Safari's biggest security feature is running web processes in a restricted environment, otherwise known as sandboxing. Pretty snazzy, except that it only runs that way on Mac OS, so it's a feature that's of absolutely no benefit to Windows users—boo! On the plus side, it's rather easy to disable JavaScript, pop-up windows, and plugins from the Security tab in Preferences. Safari will also warn users when visiting a website it deems fraudulent.

PRIVACY

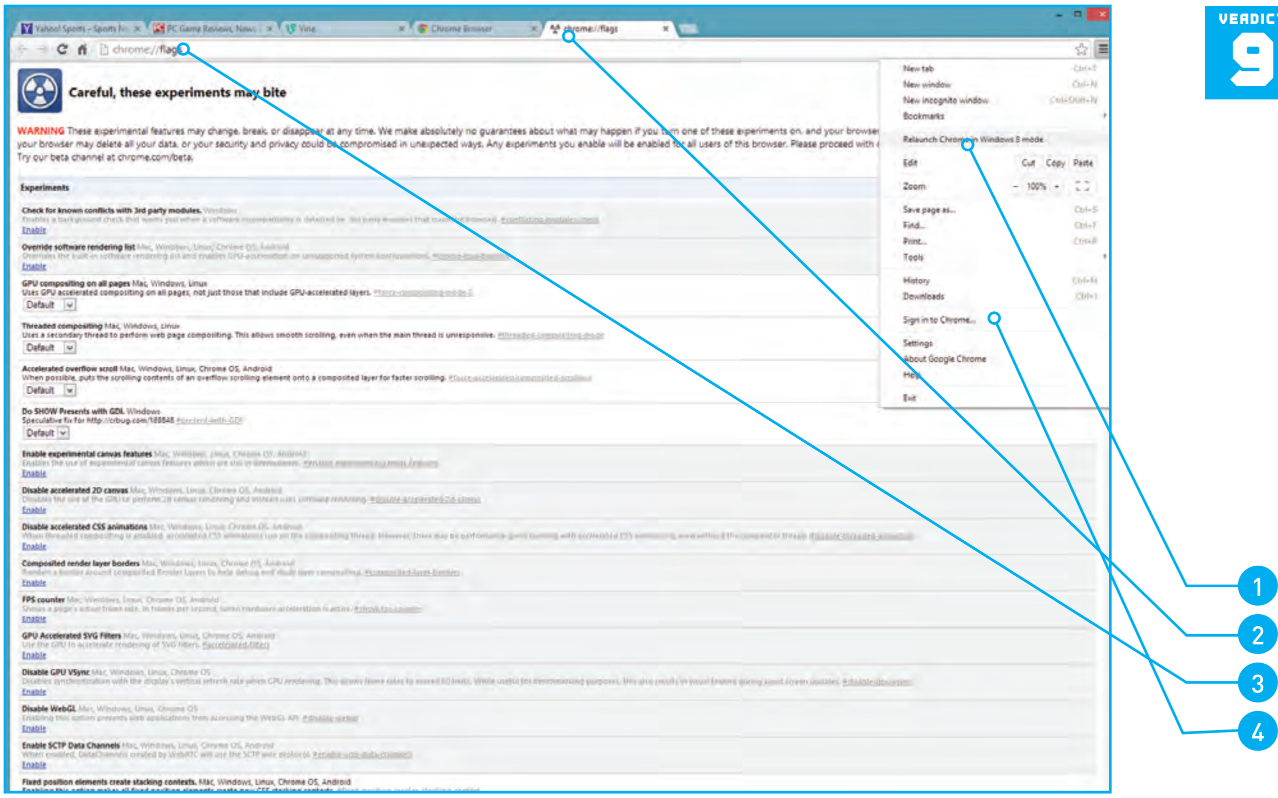
Safari blocks third-party cookies by default, a feature that's found in the browser's Privacy panel. It also contains an option to remove all website data with a couple of mouse clicks. In the same panel is an option to limit web-

1) If you're not digging Internet Explorer in Windows 8's Modern UI, you can swap it out for Chrome. Once you do, it always runs that way, even if you launch Chrome from the desktop.

2) There's no need for a dedicated search bar in Chrome. The Omnibar (or address bar) also functions as a search bar.

3) Type chrome://flags in the Omnibar to bring up a wealth of experimental features to play around with. As always, be careful flipping switches willy-nilly, lest Chrome start acting in unexpected ways.

4) Signing into Chrome allows you to sync your settings and data from one PC to another. Just sign into the same account when you get home to bring up your work PC's Chrome session.



VERDICT 9

site access to location services. Some websites use information about your location to enable certain features and services, but if you'd rather keep that information private, you can disable it altogether or be prompted when a website requests your whereabouts.

PERFORMANCE

In the majority of benchmarks, Safari came in dead last, especially when testing for JavaScript performance. The dated browser supports limited hardware acceleration in Windows, but it wouldn't even run two of the three Microsoft test demos.



Click the Reader button in the address bar to de-clutter noisy websites and side-step pop-up ads.

VERDICT 4

PREVIEW

INTERNET EXPLORER 11

AN OLD BROWSER REBORN AND BRED FOR WINDOWS 8

It wouldn't make sense for Microsoft to rebuild Windows without also revamping the parts that integrate with it, and so what we have in Internet Explorer 11 is a vastly different browser compared to previous releases. Yes, it will probably be available for Windows 7 by the time you read this, but it's really intended to complement the vision Microsoft set out for Windows 8, which includes a heavy dose of touch interaction and interoperability across a range of Windows devices and screen sizes.

While the version we're testing is a Preview release, it's very close to what the final build will be like, unlike an early beta, which could be missing key features and/or suffer from stability issues.

WHAT'S NEW

When firing it up from the Start screen, IE11 looks and feels like a brand-new browser rather than an upgrade of an existing one. That's not really surprising since the same could be said of Windows 8 compared to previous versions. The first thing you'll notice is that Microsoft moved the address bar to the bottom of the browser. It hides out of view to give you a full-screen browsing experience, though you can bring it back up with a right-click or swipe up from the bottom. If you have a touchscreen, you'll also use swiping gestures to navigate forward and backward.

Outside of touch controls, the feature we're most excited about is side-by-side browsing. While Windows 8 insists on running applications in full-screen mode, the side-by-side feature in IE11 allows you to view multiple websites at the same time, and you can resize the width of each one. This is handy for comparison shopping, among other uses.

We're only scratching the surface here. Microsoft lifted the limit of open tabs from 10 to 100 per window, which appear as scrollable tiles just above the address bar. Non-active tabs are suspended so they don't drag down your PC's performance or adversely affect battery life. Microsoft also implemented hardware-accelerated 3D web graphics through WebGL, plug-in-free HTML5 video support, and the ability to pin websites as live tiles on the Start screen—phew!

SECURITY

By default, IE11 turns on Enhanced Protected Mode (EPM), which only allows compatible add-ons like toolbars, browser helper objects (BHOs), and extensions to load. Furthermore, EPM shoves untrusted web content into a restricted environment sort of like a sandbox.

Instead of letting WebGL content run wild, it's put through a prescreening stage in IE11. It also runs on top of DirectX, so if malicious content bombards the GPU and takes it out, it will reset rather than crash the entire system.

PRIVACY

Microsoft was the first browser maker to turn on its Do Not Track feature by default, and that setting is retained in IE11. New to IE11, however, is a User-Granted Exceptions option so that users can grant permission to websites to use cookies that request it.

InPrivate browsing mode is still available in IE11, though it's not obvious when surfing from the Start screen. You can use the keyboard shortcut (Ctrl+Shift+P) or bring up the Tabs menu and press the Tab tools button on the right-hand side.

PERFORMANCE

IE11 posted the best SunSpider score in this roundup, which measures JavaScript performance. It was also the fastest in Microsoft's 3D demos, especially Lawn Mark 2013, a benchmark Microsoft claims "uses emerging HTML5 techniques." We're a bit skeptical of the discrepancy in scores, as are Chrome developers, one of which stated in a Chromium forum that the benchmark is "running intentionally slow JavaScript in all browsers besides IE." Still, it shows that IE11 is able to render 3D graphics at a fast clip, and surfing the web certainly feels fast as well.

POWER-USER TIPS

1. To add a website as a live tile, click the Star icon (Favorites) and then the Pin icon.

2. You can pin the address bar permanently to the bottom of the screen by bringing up the Charms menu (swipe or press Windows Key+C) and selecting Settings > Options. Under the Appearance heading, flip the dial to On.

3. Sites not showing up correctly? Fire up IE11 in Desktop and press Alt. Select Tools > Compatibility View settings.

THE STRAIGHT DOPE

With all due respect to die-hard Firefox fans, the spunky browser is no longer our favorite vehicle for surfing the web. That distinction now belongs to **Chrome**, the sleekest and fastest browser available. Our primary gripe with Chrome in our last browser roundup two years ago was that it didn't support hardware acceleration without mucking around with secret code. That's long been addressed and our only lingering concern is that Google may cater to advertisers a bit too much, hence it being the last of the major browsers to implement Do Not Track technology, which still isn't turned on by default.

We also have to give props to Microsoft for its work with Internet Explorer 11. If you're rocking a touchscreen in Windows 8/8.1, you may prefer to use IE11 over Chrome simply because it's better suited for touch navigation. It's also fast, though we're calling shenanigans on Microsoft's own tech demos, which seem to heavily favor its own browser over the competition, even though others also boast GPU acceleration. Still, it's the best version of IE yet, and we especially like the side-by-side browsing feature when launching the browser from the Start screen.

Where does that leave the others? Firefox is still a great browser with a rich catalog of extensions, and Opera is one to keep an eye on now that it shares DNA with Chrome. That leaves Safari as the odd man out, a decision Apple ultimately made for the masses by discontinuing support for Windows.

1) Side-by-side allows you to view multiple pages in separate, resizable Windows.

2) It's not the least bit obvious, but those three dots designate the Tab tools option. Click or tap to initiate an InPrivate browsing session.

3) You're no longer limited to just 10 open tabs. In IE11, you can have as many as 100 per window. Equally cool is the preview view of each one, which you can scroll through.

4) Microsoft relocated the address bar to the bottom of the browser where it's better optimized for touch. Just swipe up from the bottom (or right-click your mouse) to make it appear.



VERDICT 8

BENCHMARKS

	Firefox 23	Chrome 29	Internet Explorer 11	Opera 15	Safari 5
Futuremark Peacekeeper	2,348	**3,760**	WNR	3,536	1,803
SunSpider 1.0.1 (ms)	179.8	194.4	**159.1**	205.8	244.7
Google Octane v1	14,227	**15,075**	9,965	14,919	3,188
NonTroppo Table Rendering (ms)	527	338	589	383	**190**
GUIMark 3 (fps)	**62.56**	61.66	59.98	59.85	60.68
Mozilla Kraken 1.1 (ms)	1,994.9	**1,727.5**	3,182.5	1,749.5	12,493.7
Acid3	100	100	100	100	100
Microsoft Beta Fish IE Demo (fps)	60	60	60	60	60
Microsoft Penguin Mark Demo	168	185	**9,479**	66	WNR
Microsoft Lawn Mark 2013 (sec)	488.35	543.05	**11.17**	514.31	WNR
HTML5Test.com	428	**476**	361	451	280
ClubCompy	10,128	**21,893**	16,656	20,324	13,384

Best scores are bolded. Our test bed is an Intel Core i7 930, Asus P6X58D Premium, 12GB Corsair DDR3/1866 RAM, Radeon HD 7970, OCZ Vertex 3 240GB SSD, and Windows 8.1 64-bit.

iFixit presents:

AUTOPSY

THIS MONTH WE DISSECT...

Google Nexus 7



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



BACKGROUND:

The follow-up to the original Nexus 7 is not only thinner, narrower, and taller than its predecessor, but it also adds a rear-facing camera and an upgrade to stereo sound. Here's what it looks like inside.

MAJOR TECH SPECS:

- 1.5 GHz Qualcomm Snapdragon Pro S4 processor
- 7-inch 1920x1200 IPS LCD screen
- 2GB of RAM
- Adreno 320 GPU
- 5MP rear-facing camera
- 1.2MP front-facing camera
- Android 4.3 Jelly Bean

KEY FINDINGS:

- Rejoice! All we need to open this tablet is a plastic opening tool. The first glance reveals a huge battery, the standard for tablets these days.

- Although inductive charging has been around for a while, this is the first time we've seen it in a tablet since the HP TouchPad. We're pleased with the trend, as it may help eliminate wires as a source of e-waste in the future.

- Seals cover two of the screws in the Nexus 7—one on each of the main boards—so replacing either board will likely void your warranty.

- The battery tray comes out, no problem. The tray is held in place by only a few screws (yay!), but the battery is secured to the tray with pretty sticky adhesive (boo!).

- Then, out comes both the daughterboard, which houses a single IC nested among the connectors, followed by the motherboard, which holds all the other chips controlling this device.

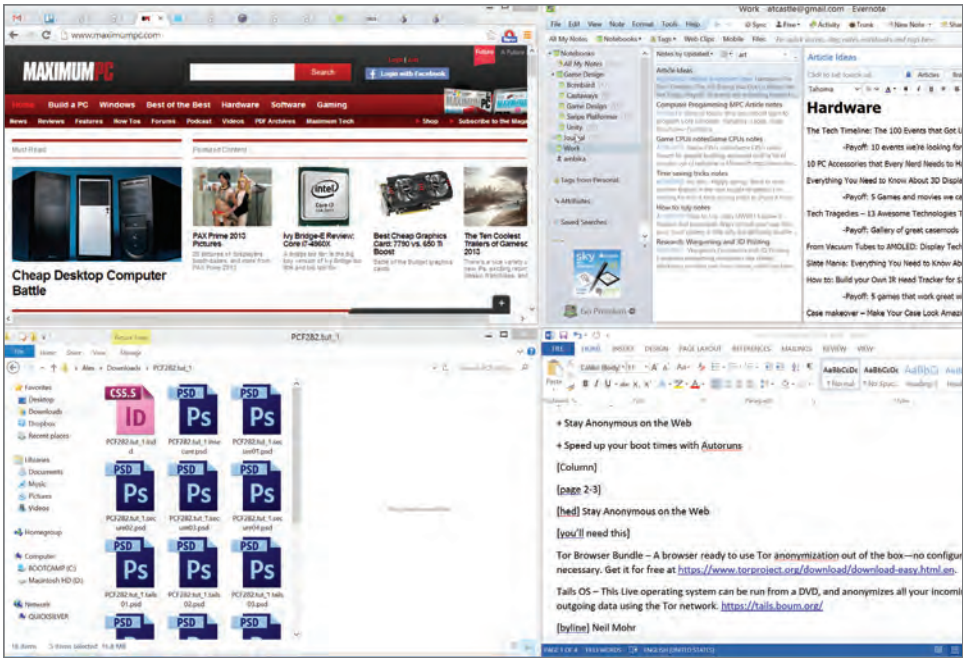
- The front- and rear-facing cameras are easy pickings, as are the updated speakers. Speakers removed, we find the rear of the front panel, home to the Wi-Fi antennas.

Repairability score: 7 out of 10. The rear case is very easy to open, and requires minimal prying effort with a plastic opening tool to remove… but we cracked it, even though we were quite careful during the opening procedure. All fasteners inside are Phillips screws. While the battery enclosure is easy to remove, some patient spudgering will be necessary to peel the battery off the tray. The front glass is adhered to the display frame, meaning you'll need a heat gun to get the LCD out—or be forced to replace the whole front panel.

HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

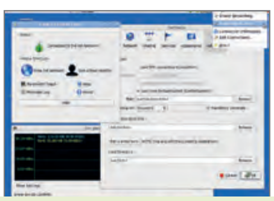
WINDOWS TIP OF THE MONTH



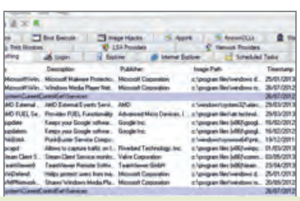
AUTOMATICALLY POSITION WINDOWS SIDE-BY-SIDE

You probably know that since Windows 7 you can lock a window to one side of your desktop by dragging it to the edge of the screen, but do you know that you can automatically snap up to four open windows into a grid? Just right-click the taskbar and select "Show windows side by side."

MAKE - USE - CREATE



66
Stay Anonymous on the Web



68
Speed Up Your Boot Times with Autoruns



ALEX CASTLE
CONTRIBUTING EDITOR

VERIFY A DOWNLOAD WITH MD5 HASHES

ONE OF THE HOW-TO ARTICLES this month shows you how to use Tor and the Tails OS for powerful web anonymization. These apps are great privacy tools, but as with any security-sensitive software, they're only effective as long as they haven't been tampered with. That's why it's always important to download files directly from the developer's website, or from a trusted third-party mirror linked to on the developer's website.

For maximum peace of mind, and to make sure that the software didn't get corrupted during the transfer, you can check the downloaded file's MD5 hash. To do it, just use an MD5 checker (such as the free online MD5 checker at www.onlinemd5.com) to generate a hash code for your file, and compare it against the MD5 hash available on the developer's website. If the two codes aren't exactly the same, something has gone wrong with the download and you should try again, from a different mirror.

↘ submit your How To project idea to: comments@maximumpc.com

Stay Anonymous on the Web

YOU'LL NEED THIS

TOR BROWSER BUNDLE

A browser ready to use Tor anonymization out of the box—no configuration necessary. Get it for free at http://bit.ly/gWL2oF.

TAILS OS

This live operating system can be run from a DVD, and anonymizes all your incoming and outgoing data using the Tor network. Get it free here: https://tails.boum.org.

IF YOU'VE BEEN following the news since this summer, you know that privacy on the Internet is something you shouldn't take for granted. Even basic computer safety (safe passwords, no open Wi-Fi networks, etc.) isn't enough to keep your online data safe from Big Brother's prying eyes. If you're not OK with your online life being an open book, you should learn to use Tor—the most secure web anonymizer around.

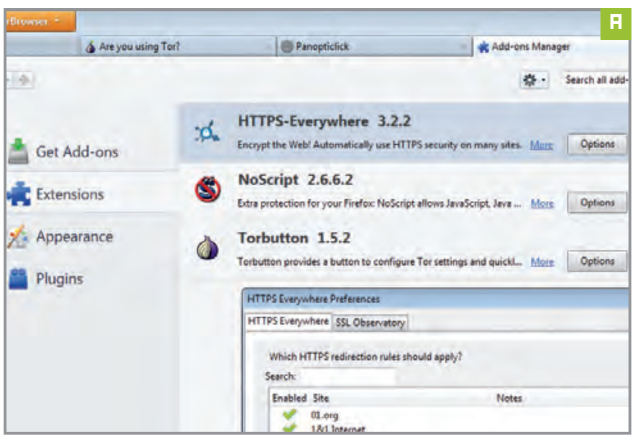
How does Tor let you browse anonymously? Imagine you're in a crowd. You give a parcel to person A, and they take it and a secret delivery card that says to take it to a random person (we'll call them B). Person B removes the security wrapping paper and gets another encrypted card telling them to take it to another random person (we'll call this one C). Another layer of security paper is removed by C, revealing the final destination and the contents. A and B can have no idea what the destination is, B and C have no idea where it came from, and A and C have no knowledge that the other exists. Tor uses a similar process, sending your data through a number of random nodes before it reaches its destination.

Tor certainly has its limitation and shortcomings. Like all things Linux-based, it's overly technical, and its unintuitive installation could be another major obstacle. The Tor project has done a good job of circumventing this complexity, mainly by supplying an easy-to-use browser and live CD-based solutions. We're going to take you through using both. The browser is fine for web-based action, while the live CD offers a full, working Linux installation with Tor installed as the Internet proxy alongside suitable services. This can also be easily installed via a USB drive or permanent system. –NEIL MOHR

1 USE THE TOR BROWSER BUNDLE Download and extract the Tor Browser Bundle from www.torproject.org. In the Tor Browser folder, run StartTorBrowser.exe. The Vidalia Control Panel appears and will make a connection to the Tor network. This can take a few seconds. When the Tor Browser opens, it's simply a branch of the Firefox code, specifically configured to use the Tor network with a number of pre-configured plugins.

» The Tor Browser lets you know what your "new" IP address is; as you go from site to site this is what's recorded, rather than your real IP. Click the top-left Tor Browser button and select Add-ons (**image A**). You'll then find the three default plug-ins that come with it: HTTPS-Everywhere forces encrypted web transfers, NoScript blocks tracking and malicious scripting, and Torbutton offers quick settings.

» The Tor network itself needs no configuration—the browser will merrily work away as it stands. The Vidalia Control Panel offers complete control and reporting of the network status. There's also an accurate bandwidth monitor and an interesting Network Map showing how the Tor network is built up.



2 RAMP UP WITH TAILS TOR OS For more than simple browsing, the Tails Tor OS is the most secure option available to you. It's a Linux operating system that uses the Tor network to anonymize all incoming and outgoing traffic. You can run Tails directly from a USB drive or DVD, or as a virtual machine in VirtualBox (available for free at www.virtualbox.org).

» Whichever option you choose, you'll need the Tails OS ISO, which you can download at https://tails.boum.org. If you're using VirtualBox, click New, type **Tor** then select Next > 512MB > Next > "Do not add a virtual hard drive," and click Create. Select the new Tor machine and click Settings > Storage > Empty > Live CD/DVD—you'll then need to select the Tails ISO image file and click OK (**image B**).

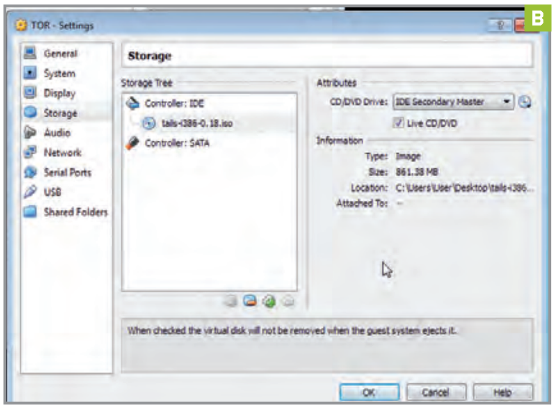
» Everything that follows will work if you run Tails from a DVD or USB key, but we'll be using the virtual machine for ease of access. Double-click Tor and allow it to boot. You can also opt for More Options and set an admin password required for adjusting further settings.

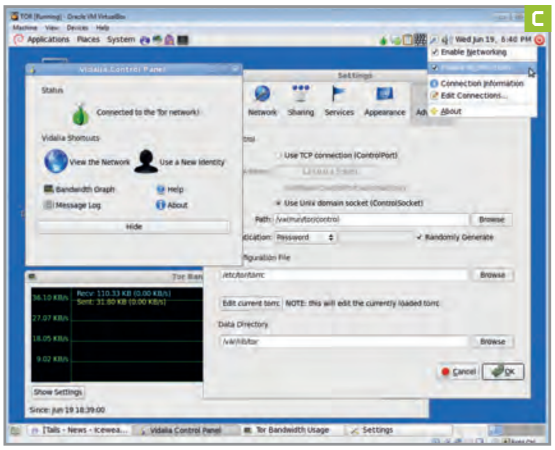
» After a minute or so, Linux and the Iceweasel Tor browser will spring into life, alongside a number of pop-up messages about time and virtual-machine warnings. In VirtualBox, use Ctrl+F to toggle Fullscreen mode or Ctrl+S to toggle Scale mode. You can even adjust the screen resolution within the OS by clicking System > Preferences and selecting the Monitors menu.

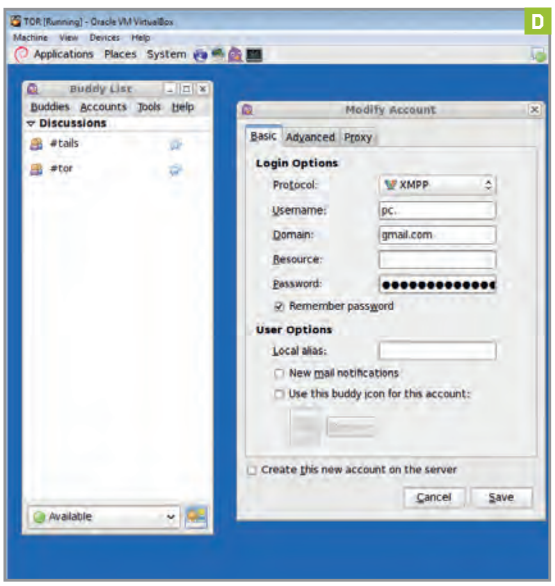
» Look for the little green Vidalia onion icon in the top taskbar—this gives you access to the same Control Panel we covered using the Tor Browser Bundle, with bandwidth, network, and the ability to establish your system as a Tor relay. The network icon next to this is handy for quickly establishing if the virtual network port is connected, in case there are any issues (**image C**).

» The instant messaging tool Pidgin is a key part of Tails (**image D**), and includes built-in OTR encryption and an email client. Pidgin supports MSN, ICQ, IRC, AIM, and Jabber protocols by default. The OTR aspect enables end-to-end encryption of conversations when used with other OTR users. To enable it, select Pidgin Tools from the Plug-ins menu.

» Tails also comes with the email client Claws. This isn't meant to be anything special, but it's also set with the OpenPGP variant GnuPG, which enables two-way auto-encrypted email. Alternatively, there's the gpgApplet clipboard, which offers basic encryption of text via a pass phrase or public key. The output can then be safely emailed, too.





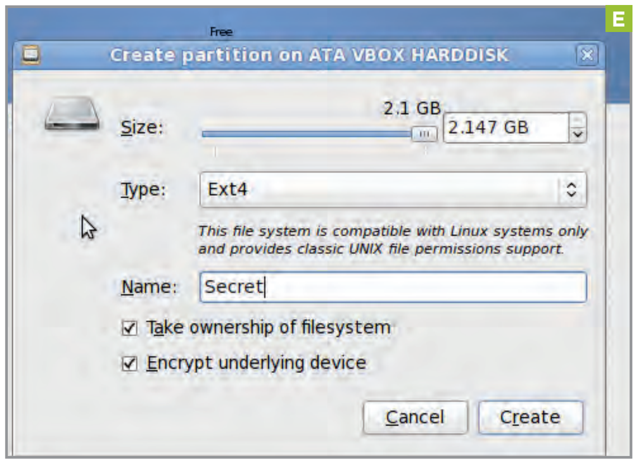


3 ADDITIONAL PRIVACY TOOLS IN TAILS The site www.duckduckgo.com has been around for a while, and its key selling point is anonymous search, which is why you'll find it in the list of the Tor Browser search engines by default. Couple its anonymous search with encrypted access and this is about as good as it gets for general searching online. It's not as capable as Google when it comes to complex queries, but it's good for general search.

» If you plan to take Tails out and about on a USB drive, it would be very wise to at least encrypt a data partition. Tails comes pre-installed with LUKS, a standard Linux disk encryption system. Select System Tools and click Disk Utility to create a partition that has encryption enabled (**image E**). This will become available via the Place menu, and will protect any files if the drive is lost.

» When Tails starts, you'll see an onscreen keyboard appear briefly—this is Florence, the virtual keyboard. You can access Florence via the keyboard icon in the taskbar. You might think it's there as a fallback or for accessibility reasons; it's actually there for the super-paranoid and anyone who suspects that a keylogger could be deployed on their system.

» For the live CD, secure wiping isn't an issue as nothing from the session can be stored. However, if you were running this from a USB drive, Tails offers two options for secure deletion. Right-click on a file and select the Wipe option—it defaults to two passes so you can ignore the Gutmann 35 option (that's an urban myth, anyway). The "Wipe available diskspace" option is for an entire drive.



Get Faster Boot Times with Autoruns

YOU'LL NEED THIS

AUTORUNS
This free application from Microsoft will help you eliminate unnecessary startup programs. Get it at http://bit.ly/J4fjvZ.

WINDOWS LOVES to run things. Programs, background tasks, drivers for things you aren't using, plugins for browsers you'd never use in the first place—it'll run them all, and at start-up.

If you're energy-conscious and switch your PC off completely when you're not using it, a full restart can take forever—even on Windows 8—if you've stuffed it with enough program installs.

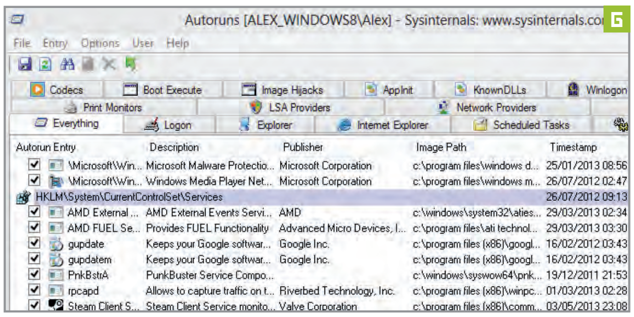
The key to preventing this is to take charge of what Windows runs and when. It's often quite safe to disable many of the items set to autorun, which means your machine will get a noticeable speed boost on boot, and when you run certain programs, too. All you need is a program called Autoruns (which is completely free) to make a nondestructive change. If you find your machine doesn't run as it should when you've switched off a few things, just turn them back on. –EDGAR SMALLS

1 INSTALL AUTORUNS

Autoruns is part of Microsoft's Sysinternals suite, which also contains a host of useful programs. You'll find the file online and you can download it from http://bit.ly/J4fjvZ. Open it up and drop autoruns.exe somewhere you can easily find it. It doesn't need installing, so you can keep a copy handy on a USB stick, too.

» The first time you fire up Autoruns, it searches all of the locations it knows of in your Registry in order to find every entry that it can manipulate—items that automatically run, or those that hide in the background. This can take a while to complete, but eventually you'll see the list begin to populate (**image G**).

» The first list you see corresponds to the Everything tab at the top of the interface, but it can be a little complicated to find what you're looking for. Click through the other tabs—paying particular interest to Logon—to see the items that are loaded at certain times, and which are related to a particular program or purpose on your PC.



2 DISABLE UNWANTED STARTUP ITEMS

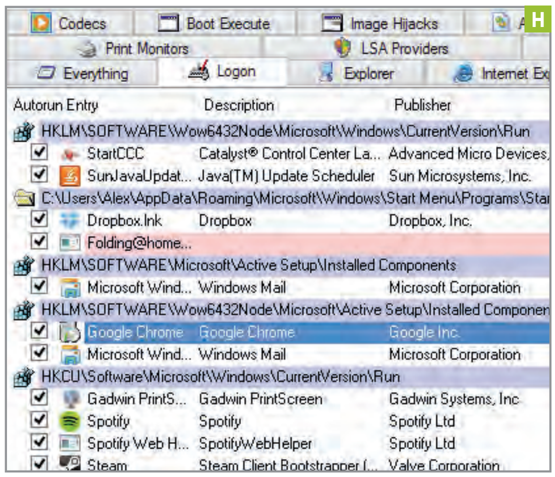
Click the Logon tab to see the programs that run when your system starts up. These could include configuration tools for your graphics card, cloud services like Dropbox, and helper applications for services such as Spotify, Steam, etc. From here, you can uncheck a box next to each option and personally determine what runs during your start-up (**image H**).

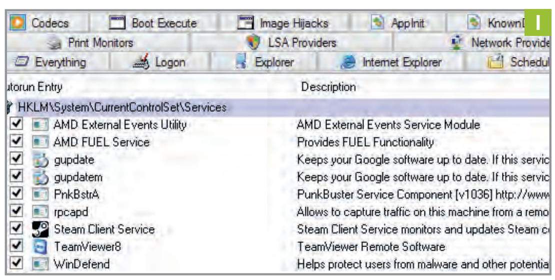
» Click the Explorer tab and look at the list. Chances are, you've installed a program or two that integrates itself with Windows Explorer in some way, probably in a right-click menu. You can choose to disable those menu entries in this tab without removing the program itself, which is handy if you like streamlined menus.

» The Scheduled Tasks tab lists everything set to run automatically in the future. While we wouldn't say that Autoruns is the best tool for managing these tasks—you're better off using the respective configuration tools—it's a handy way to make sure your computer is running at maximum efficiency.

» Services are small programs that run in the background of Windows, usually without any sort of interface or other indication that they might be there. Look at the Services tab to see what your machine is hiding (**image I**). We'd generally recommend leaving these switched on, since some of these services perform a valuable function.

» Changes are saved as soon as you make them, but you'll need to restart your computer to see their effects. You should notice an increase in boot speed, and the other changes you've requested should be made. If anything doesn't work as it should, simply re-enable some of the items you've disabled.





BUILD IT

TOM MCNAMARA **ASSOCIATE EDITOR**



A Haswell-based Budget Box

We all know AMD makes damned-fine budget parts, but can Intel compete? This month, we build a $650 Core i5 Haswell rig to find out how it stacks up

LENGTH OF TIME: **1–3 HOURS** | LEVEL OF DIFFICULTY: **EASY**

THE MISSION Here in the Build It section of the mag, it seems like whenever we build a high-end system it's powered by an Intel CPU, and budget systems always run AMD parts. This month, we're flipping the script and building a budget-oriented Intel system to see how it compares to AMD's offerings, and to give people a glimpse of what a $650 Intel rig can throw down. For comparison's sake, we recently built budget rigs using AMD's new Richland APU (October 2013) as well as one with a $120 Vishera FX-6300 CPU ("Battle of the Budget Builds," June 2013), and found that both chips serve their niche quite well. For this Intel build, we knew we'd go with Haswell, and wanted to run a Core i3 CPU, which typically comes with two cores and Hyper-Threading (HT), but those haven't been released yet. So, the next-best CPU we could get was the Core i5-4430— a quad-core CPU without HT for $180. That's a third of our budget on the CPU, which forced us to be frugal elsewhere. We also took this opportunity to try out a new microATX case from Cooler Master that retails for $50, which we felt was perfect for a budget build.



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GATHERING INTEL

SINCE WE'RE WORKING on a tight budget, we planned this system to be relatively bare-bones, thus allowing us to build inside the smallish Cooler Master N200 microATX chassis. This is a chassis that's smaller than a traditional mid-tower, but larger than a traditional small-form-factor case, with plenty of room for cables and extra-long GPUs. The foundation for our build would be a motherboard from Gigabyte, the GA-B85-D3H (not to be confused with the HD3). It has a fat heatsink on the parts that usually get pretty hot, so we figured the board would be relatively stable. Other than that, it is a budget B85 board, with four SATA 6Gb/s ports, Realtek integrated sound, one PCI Express 3.0 slot, and four RAM slots that can handle up to 32GB clocked at 1,600MHz. It also features Gigabyte's DualBIOS feature, so the motherboard can use the backup BIOS if the primary one fails to boot. The Core i5-4430 isn't overclockable, so we won't be messing with any of that. Although the Core i5-4430 is about $30 more expensive than the A10-6800K that we tried in the AMD budget build, that CPU also wore a Cooler Master Hyper 212 Evo cooler, which comes out to... about $30. So it's the same difference in the end, though CPU and integrated graphics performance will differ.

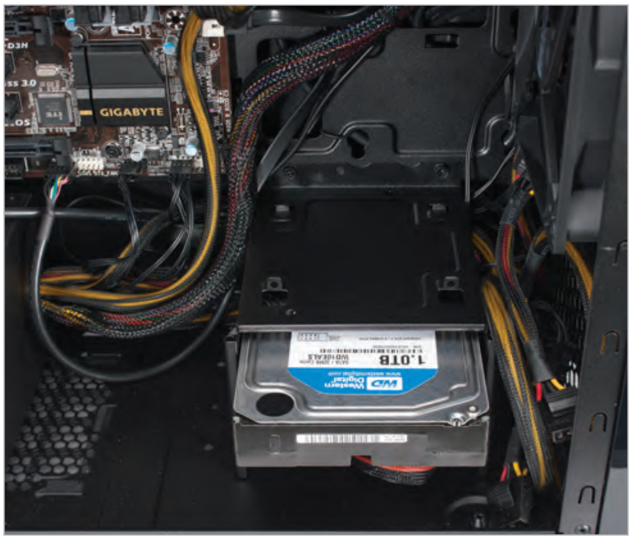
Other than that, we're trying to keep the rest of the system similar to the Richland build, to create a level playing field, so you'll see the same 60GB SSD, Corsair power supply, 1TB hard drive, Windows 8, and an optical drive.

INGREDIENTS

	PART	PRICE
Case	Cooler Master N200	$50
PSU	Corsair CX500	$50
Mobo	Gigabyte GA-B85-D3H	$85
CPU	Intel Core i5-4430	$180 (street)
Cooler	Intel stock cooler	N/A (bundled)
GPU	Intel HD 4600	N/A (integrated)
RAM	2x 4GB Corsair Vengeance LP	$60 (street)
SSD	60GB Mushkin Chronos MKNSSDCR60GB-7	$65 (street)
HDD	1TB Seagate Barracuda	$68 (street)
Optical Drive	Samsung SH-S223	$15 (street)
OS	Windows 8 64-bit OEM	$90 (street)
TOTAL		$663

1 STATING YOUR CASE

THE N200 case is about 7.5 inches wide, so cable management quickly becomes an issue as soon as you begin inserting parts. As we began building, the first area of trouble we ran into was with the hard drive cage on the bottom of the chassis, which holds two 3.5-inch drives and one SSD. If we were to use the standard screw holes for the hard drive, it would have given us very little clearance to connect the SATA and power cables on the other side. So we moved the HDD forward by one hole, which gave us some extra space in the back, making it easier to store unused power supply cables out of sight. It's a shame the hard drive cage doesn't have rails, as installing drives is a PITA.



2 GETTING CAGEY

IN ORDER to install hard drives into the included cage, you need to attach screws to both sides of it, but there's no way to access the cage's left side with it inside the system, so you have to remove it altogether first. To do that you need to remove two screws that secure it to the motherboard tray, then flip the case on its side to access four more screws underneath the case (pictured). With those removed, you can pull out the cage and access the holes on its left side.

There are also four built-in SSD installation points—one on top of the lower HDD cage, two on the mobo tray, and one beneath the upper 3.5-inch drive bay—but we used an adapter bracket to install our lone SSD in the 3.5-inch cage. Call us old-fashioned, but we felt it offered the cleanest wiring options. The upper 3.5-inch drive bay also holds a single drive, so despite the N200 being "only" an mATX case, you have plenty of options when it comes to storage.



3 INTERCEPTING CABLES

A MODULAR power supply probably would have been easier to use in such a small case, but we used the same PSU from our Richland build, so we had no choice but to find room for all the cables. The side panels each have a bulge to them, but they're not deep enough to squeeze a 24-pin power cable behind the motherboard tray. There's also no cutout for the 8-pin power cable, so we had to route it over the motherboard like in the old days. Since there's no window on this case, we didn't feel too pressured to make the inside look pretty, but we did break out the twist ties in a few places.



4 LASER VISIONS

OPTICAL DRIVES are still the easiest way to install Windows, so we'll continue to use them until we're pulling an OS from the cloud. Plus, some motherboards don't play nice when you try to boot from a USB stick, especially if it's a USB 3.0 device. To install an optical drive with this case, you need to remove the front bezel via a hidden handle at the bottom that pulls outward. Once it comes off, you squeeze two tabs on the drive bay cover to remove it. You can see from the photo that the entire front of the case is just one big mesh grill. It holds two 120mm fans, or a 240mm radiator on the inside of the chassis. Though we didn't install a closed-loop cooler this time, it certainly can be done, but it makes for a very crowded interior. Once you put the front bezel back in place, smack it in each corner nice and hard.



5 ERROR CODES

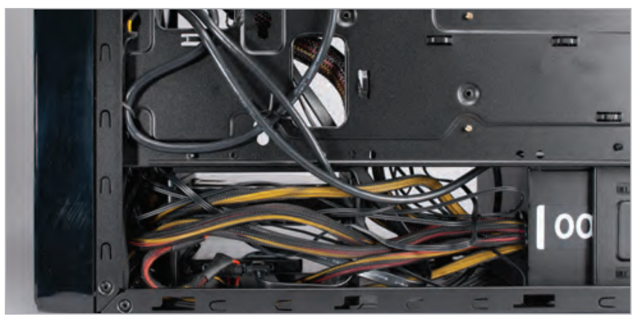
WE USE A VARIETY OF monitors around the Lab, and during this build we happened to spot an unused 30-inch Dell with a resolution of 2560x1600 looking at us longingly. We thought it would be fun to test the system at that resolution, so we hooked it up only to find that we'd made a small oversight. The DVI connection on the back of this particular motherboard does not support dual-link DVI, it's single-link only. To distinguish the ports visually, DL has more pins in it—24 as opposed to single-link's 18. You need dual-link to get a 60Hz refresh rate at resolutions above 1080p. DisplayPort accomplishes this objective as well, but this board did not have that connector either, leaving us stranded on 1080p island. D'oh! For what it's worth, you can get a motherboard in this price range with dual-link DVI, such as the MSI H87-G43, but that board has one fewer fan header than this Gigabyte board! Those fan headers come in handy, too, because this case has three fan mounts unused right out of the box, on the top, side, and front. The top even accepts 140mm fans, and the case comes with anti-vibration grommets.



6 LOOSE ENDS

ONCE WE HAD mostly finished our build, we had to find space in the chassis to stash all of our cables, which is tricky in a case this size. Even cables that are in use need to have their middle parts tucked away. By moving our hard drive forward a bit in its drive cage, we were able to free up space behind it, into which we stuffed a lot of cables. We also took advantage of the small gap between the drive cage and the front of the case. Ideally, we would have spread these cables out behind the motherboard tray, but the side panels only bulge a few millimeters, and it didn't seem worth it to squeeze the cables that much just to clean things up, especially when there's no case window.

One slick feature of this chassis is that the internal 120mm intake fan can be moved to the outside of the case, where it sits behind the front bezel. This is handy if you're trying to set up a push-pull configuration on a radiator mounted inside the front of the case, though you'd need to remove the hard drive cage to accommodate such a setup.





1. The top fan mount has a pre-installed dust filter. It's attached by four plastic plugs that pop off easily.

2. The intake under the power supply also has a dust filter. It slides out from the rear for easy cleaning. The PSU area sports rubber anti-vibration feet.

3. The N200 has a decent amount of drive bays, but unfortunately none of them are tool-less. Drive installation is more difficult than it should be.

4. If you want to install a 240mm radiator in the front, you can squeeze its fans into the bezel. Otherwise, the drive cage needs to be removed.

BACK TO THE HASWELL

BUILDING SYSTEMS in these small cases always poses challenges, but it wasn't too bad this time around. It was a bit time-consuming to install the SSD and HDD, since the drive cage had to be removed, but the rest of the build was fairly painless. Once it was up and running, we were surprised by how quiet it was, despite the front of the case being nothing but mesh. You'd think some noise would leak through there, but the system was just about silent, even under full load. In fact, one time it ran for a minute or so without the CPU fan even spinning (the fan cable got caught in the blades, before we secured it with a twist tie). The case fan cables are also about 18 inches long, so they'll reach all the way from one end of the N200 to the other.

In terms of general desktop performance, we already had a good idea of what to expect since we had already tested Intel's Haswell CPU (see the August issue, page 42). In testing, the Core i5-4430 was able to encode videos and render hi-res panorama photos much faster than a comparably priced AMD CPU. Even when we overclocked the AMD 6800K to 4.7GHz, it couldn't keep up with a Core i5-4430 running at 3GHz.

The same can't be said for its gaming performance, though, as AMD clearly takes the crown from Intel. In general, Haswell's HD 4600 graphics are around 40 percent slower than the AMD 6800K's graphics. Then again, the Core i5-4430's non-GPU performance outclasses either AMD chip.

In the end, going Intel or AMD at this price range really comes down to what your needs are. You can get an FX-6300 for about $120 right now and add a Radeon HD 7770 for about $75 (at least after a mail-in rebate). So, for gaming on a budget, AMD provides the best value. If you're editing HD videos and hi-res photos, though, Intel wins by a comfortable margin.

All in all, the Intel system put up a heck of a fight against the AMD builds, at least in the computing realm; not so much in gaming. The system was fast enough for basic needs though, and if we had used a motherboard with DisplayPort and/or DL-DVI, we could call this build an all-around success.

BENCHMARKS

	ZERO POINT	
Stitch.Efx 2.0 (sec)	1710	1135
ProShow Producer 5.0 (sec)	1,947	1685
x264 HD 5.0 (fps)	9.0	11.65
3DMark11 Performance	1668	1237 (-26%)
Stalker: Call of Pripyat (fps)	8.3	8 (-3.5%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our Richland system was a quad-core 4.1GHz A10-6800K at 4.7GHz, 8GB of Kingston DDR3/1600, on a Gigabyte GA-F2A85X-D3H motherboard. It ran Radeon 8670D integrated graphics, a Mushkin Chronos SSD, and Windows 8 64-bit.

REVIEWS

TESTED. REVIEWED. VERDICTIZED.



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ORIGIN GENESIS PAGE 76



The Origin internal wiring surpasses that of the two other super PCs we've seen lately.

Origin Genesis

Think of it as Dream Machine, but with an Ivy Bridge-E inside

IT DIDN'T TAKE long after Dream Machine 2013 hit the stands that readers collectively wondered: "Whiskey tango foxtrot, no Ivy Bridge-E?"

Yes, gentle readers, we hear you, and believe us when we say that about this time every year for the last 17 years, we've wondered what Dream Machine would be like if we had just had X piece of hardware to jam in there instead.

Well, guess what? Now you don't have to wonder. Sure, in many ways Origin's Genesis doesn't look anything like this year's Dream Machine—in fact, it's the polar opposite aesthetically, with its red and black motif applied to the Corsair 900D case—but it's still clear both machines share a parent.

Inside the Genesis you'll find four liquid-cooled GeForce GTX Titans—albeit overclocked higher than Dream Machine's—as well as an Asus Rampage IV Extreme mobo. But locked into the LGA2011 socket, behind the Koolance water block, is Intel's shiny, new Core i7-4960X CPU. That's the same chip we write about on page 26, but if you don't care to flip back, it's basically the new performance king of multithreaded apps (at stock speeds, anyway.)

Taking advantage of the Koolance water block and dual 480mm rads, Origin pushes the Ivy Bridge-E to an overclocked speed of 4.5GHz, with Turbo left on to take the cores to 4.9GHz under some loads. Those dual rads also keep the quartet of Titans cool, in conjunction with a gorgeous set of EK-FC water blocks.

Having seen two other liquid-cooled boxes recently with four-way Titans (Dream Machine 2013 and October's Primordial Medusa), we have a pretty good frame of reference for just how much performance you can squeeze out of such systems.

Let's just ignore our zero-point system, which clearly is not in the same class here, and stack the Genesis against just those two other super PCs.

Against the Primordial Medusa, the Origin Genesis leads the way. Mind you, the Primordial pairs its four Titans with a Core i7-3930K at "just" 4.5GHz. The Genesis beats it in every benchmark by 6–8 percent, which is a pretty sizeable margin when you're running in this class. Against Dream Machine 2013, it gets stickier. DM2013's Core i7-3970X is clocked all the way to 5GHz full-time. In other words, it's a 5GHz Sandy Bridge-E versus a 4.5GHz, or so, Ivy Bridge-E. Who wins? In CPU chores, it's virtually a tie, with the 4.5GHz IVB-E trailing by about 1 percent in everything except ProShow Producer 5.0. In that one benchmark, the 11 percent clock advantage of Dream Machine 2013 (assuming the Origin Genesis operates at 4.5GHz mostly) gave DM2013 a 4 percent performance advantage.

In gaming, the Origin Genesis gets payback. Its score in Batman: Arkham City is an astounding 9 percent faster. We credit the Ivy-E, not only for its efficiency but also for its lower power consumption. We think that let Origin push its GPUs higher than was possible with DM2013. As a result, the Genesis now holds the top score for 3DMark 11 and Batman: Arkham City.

It's not all about performance, though. The Genesis's fit and finish is top notch. We'd rank it above that of the Medusa and the DM2013, in all honesty. Well, except that Origin didn't go all the way with the paint job—portions appear to be the factory 900D finish.

In the price department, the Origin Genesis doesn't win any battles. At $11,000, it's probably one of the most expensive production machines we've ever reviewed. The Medusa actually scraped $9,500, although Primordial took the compromised route of using a 1TB HDD and pair of 120GB SSDs to save cash. We prefer the 1TB SSD–plus–4TB HDD route that Origin took, but that also helps push the price higher. But hey, at least you can say it's cheaper than this year's Dream Machine, which hits $12,660 for the box alone. And that's with zero warranty and support, of course. Origin offers a lifetime labor warranty along with a three-year warranty on parts.

Frankly, after going through the hassles of building the Dream Machine, we can see the appeal of buying a full-on, prebuilt super PC because it ain't always easy working with these monsters. –**GORDON MAH UNG**

VERDICT
9
KICK ASS!

Silverstone Tundra TD03

+ GENESIS PLANET Tight wiring; could be Dream Machine's evil twin.

– GENESIS (BAND) Expensive; case not fully painted; loud.

$11,000, www.originpc.com

BENCHMARKS

	ZERO POINT	
Premiere Pro CS6 (sec)	2,000	1,627
Stitch.Efx 2.0 (sec)	831	676
ProShow Producer 5.0 (sec)	1,446	1,208
x264 HD 5.0 (fps)	21.1	26.4
Unigine 4.0 (fps)	76	194 (+155%)
3DMark 11	5,847	17,360 (+197%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our current desktop test bed consists of a hexa-core 3.2GHz Core i7-3930K 3.8GHz, 8GB of Corsair DDR3/1600, on an Asus Sabertooth X79 motherboard. We are running a GeForce GTX 690, an OCZ Vertex 3 SSD, and 64-bit Windows 7 Professional.

SPECIFICATIONS

Processor	Intel Core i7-4960X@4.5GHz
Mobo	Asus Rampage IV
RAM	16GB Corsair DDR3/1866
Graphics	Origin Cryogenic Liquid-Cooled EVGA GeForce GTX Titan cards in four-way SLI
Soundcard	Onboard
Storage	1TB Samsung 840 Evo SSD, 4TB WD Black HDD
Optical	LG Blu-ray drive
Case/PSU	Corsair 900D, EVGA SuperNova 1,500 PSU



MSI includes a separate utility just for the card's fans, letting you control the outer ones separate from the inner fan.



MSI N780 Lightning

Too exotic (and expensive) for mere mortals

BACK IN OCTOBER, we took a look at the MSI GTX 770 Lightning, which was a bit like a hot rod that had been given a little too much go-go juice. It was fast, and provided a plethora of performance options for horsepower junkies, but it was simply unstable, even at stock clocks. Undaunted, MSI followed it up by sending us an even bigger, badder board in the same series, the GTX 780 Lightning. Like the other Lightning cards, this is the cream of the crop from MSI in terms of board design, cooling, features, and clock speeds. In other words, if you are looking for the fastest non-Titan board MSI offers, this is it. Unfortunately for MSI, though this board was quite stable overall, we didn't see enough of a performance advantage over other GTX 780 cards to justify its outrageous $750 sticker price.

To its credit, MSI has made this card pretty damned awesome and worthy of the Lightning moniker by infusing it with all kinds of badassery. For starters, it has a color-sensitive Lightning logo that changes shade (green, yellow, or red) depending on GPU load. Twin rows of blue LEDs flicker on the top of the backplate, showing GPU activity, and there's also a GPU Reactor PCB on top of the card with blue LEDs, and it supposedly helps overclocking by allowing up to 300 percent more power to surge into the card. The reactor is easily removable though, in case it causes clearance issues. The card also uses twin BIOS chips for overclockers, and a redonk three-fin setup dubbed Tri-Frozr with PWM and its own separate fan-control software. Of course, it has "military-class" everything, including a custom PCB with 16 phase power, and hardware leads for directly monitoring voltages straight off the card.

To test the card, we spent about a week overclocking it so we could take it to the maximum level of performance. We ended up with a power-target setting of 109 percent, GPU offset of 135MHz, and a small memory overclock of 220MHz. This gave us a boost clock that cycled between 1,254MHz and 1,267MHz, which was stable. Whenever it ran at 1,280MHz for any period of time, it would hard lock, so this is as high as we could take it. Overall, that's an excellent result, but not any better than what we achieved with the less expensive Asus and EVGA boards. Under load, the 780 Lightning ran at 76 C, which is also excellent and very quiet, but nothing unusual for these high-end boards.

Looking at the benchmark chart, you can see why we're puzzled by this card's price tag. It performed exactly the same in our testing as the other top-tier GTX 780 boards, yet costs $90 more than the EVGA card and $40 more than the Asus board. Now, if you're looking to do competition-level overclocking, we imagine the Lightning is the board you want, but for people who just want an air-cooled GPU that is quiet and overclocks well, it's tough to recommend this board given its exorbitant price tag. –JOSH NOREM

SPECIFICATIONS

	MSI GTX 780 Lightning	Asus GTX 780 DirectCU II	EVGA GTX 780 SC w/ ACX	GTX 780 (Reference)	GTX Titan
Driver	326.80	320.49	320.49	320.18	320.49
3DMark Fire Strike	10,078	**10,090**	9,607	8,482	9,892
Unigine Heaven 4.0 (fps)	41	**42**	40	35	40
Crysis 3 (fps)	33	**34**	27	24	32
Shogun 2 (fps)	56	56	55	48	**63**
Far Cry 3 (fps)	**42**	**42**	**42**	35	**42**
Tomb Raider (fps)	**26**	**26**	25	25	25
Metro: Last Light (fps)	**25**	**25**	24	22	**25**
Battlefield 3 (fps)	56	**58**	55	53	55
Catzilla Beta	**8,147**	8,142	7,660	6,933	7,926

Best scores are bolded. Our test bed is a 3.33GHz Core i7 3960X Extreme Edition in an Asus P9X79 motherboard with 16GB of DDR3/1600 and a Thermaltake ToughPower 1,050W PSU. The OS is 64-bit Windows 8. All tests are run at 2560x1600 with 4X AA except for the 3DMark tests.

VERDICT 8

MSI N780 Lightning

+ **XOLOITZCUINTLI** Highly overclockable; quiet and cool; looks badass.

– **SPHYNX** Way too expensive; same performance as other 780s.

$750, www.msi.com



The Lexar P10 looks slick but it's missing a decent keychain loop.



The LaCie RuggedKey is inside an orange thingy for protection.

Pocket Rockets

Four fast USB keys meet in a benchmark brawl

A USB key, aka thumb drive, is a must-have item for any hardware-fixing performance junkie, and now that USB 3.0 versions have arrived we all want the fastest one we can get our sweaty digits on. To find out which key holds the combination to our hearts, we put four models with top-tier specs through their paces. Since most of them don't come with any extras, they will be judged primarily on straight-line speed and overall usability. May the best key end up on your keychain! –**JOSH NOREM**

LEXAR JUMPDRIVE P10 64GB

Lexar's JumpDrive P10 is the successor to its Triton drive, offering the same chassis but much improved performance. It's available in 16GB, 32GB, and 64GB capacities, and is billed as a "premium" drive due to its design and performance. AT $120 (street) for the 64GB, it's the most expensive drive in this roundup, and looking at it, one can see why. The combination of brushed metal and its plastic "piano finish" top look very swank, and the solid-metal casing feels indestructible in your hand. The USB connector retracts into the chassis and slides out like a turtle head, and it takes a bit more pressure than we would like to deploy. The biggest issue with the JumpDrive's chassis is that it lacks a proper loop for your keychain. There are two teeny, tiny holes on the end that you can fit an included string into, but that's it, which is not good enough, period.

In testing, the JumpDrive showed impressive speed across the board, taking second place in the 30GB transfer, first place in the 10GB transfer, and hitting over 250MB/s in our synthetic tests. That is ludicrous speed, and is about on par with what we'd get from a midrange SSD, so kudos to Lexar for building such a fast drive. The problem is the SanDisk is just as fast in most tests, costs $50 less, and has a loop for your keychain. We love this drive's speed and smooth metal body, but not much else.

VERDICT 7
Lexar JumpDrive P10 64GB
$120 (street), www.lexar.com

LACIE RUGGEDKEY 64GB

This is the only key here that offers any impact protection, and it offers it in the form of an orange rubber sheath that protects it from falls up to 100 meters—that is, if you choose to keep the key in the sheath, since the two are not permanently attached. The key itself has a brushed-metal chassis with a narrow neck and extra-wide body to allow it to slip into its rubber cocoon for transport. When you need to use the key, you simply pull it out of the orange shell. We like that it comes with a key ring pre-attached to an even smaller loop, which could slip onto an existing key ring if you like, and that the rubber shell is optional. Everyone in the office thought the LaCie has the best design, hands-down. It's available in 16GB, 32GB, and 64GB capacities.

Unlike the other keys, LaCie quotes relatively modest specs for this puppy, saying only that it can do "up to 150MB/s." It includes LaCie's hardware encryption, which password-protects a portion of the key, and is a welcome feature. In tests, the RuggedKey was a bit slower than the other keys, especially in writes, where it hit 120MB–130MB in synthetic benchmarks; it came in third in our 10GB write test, and last in our 30GB write test. Its read speeds were respectable, though, hitting just a bit over 200MB/s.

Overall, the LaCie is a well-rounded package. You trade a bit of speed for a great design with excellent features.

VERDICT 9
LaCie RuggedKey 64GB
$100, www.lacie.com

CORSAIR FLASH VOYAGER GS 64GB

Corsair's new Flash Voyager comes in a scratch-resistant brushed-metal shell that is thin, wide, and flat. It features a small, plastic "loop" at one end for at-



We're not sure why Corsair thought the GS needed a removable cap.



SanDisk's Extreme is extremely affordable, that's for sure.

taching to a keychain, and a removable cap on the other end, which we makes us grumpy since they are so easily lost. It's available in 64GB, 128GB, and 256GB capacities, and is the fastest USB key the company offers, rated for speeds up to 260MB/s read and 70MB/s writes. It includes a five-year warranty and its pricing places it smack-dab in the middle of the pack. It's important to note that its wide design could block other similarly wide devices at adjacent ports, and though the key's body is metal, the small piece on the end that slides on a keychain is plastic, so we can already see it snapping off a year down the road.

It's too bad there are issues with its shape and size, because it offers superb performance. It was the fastest drive in our 30GB file copy and in both of our sequential read speed tests, hitting an eye-popping 296MB/s in CrystalDiskMark. It also posted the fastest sequential-read speeds in the synthetic AS SSD test, which uses incompressible data such as JPEGs and MP3s, making the Corsair a top-notch performer.

On the whole, this is a fast and affordable package. We don't like the form factor, however, which includes the too-small plastic "loop," the removable cap, and a wide body. If you're using a lanyard, we highly recommend it, but keychain users should shop elsewhere.

VERDICT 8
Corsair Flash Voyager GS 64GB
$80 (street), www.corsair.com

SANDISK EXTREME USB 3.0 64GB

The SanDisk Extreme USB key is the most basic and un-fancy USB key in the group, with an extremely light plastic chassis and a no-frills slide-out USB key. We love retractable keys, though, and we also appreciate that it has a small loop for our keychain, so in our opinion, this key's simple design is spot-on. When holding it in your hand it feels like it weighs nothing at all, which some staffers disliked; its USB connector flicks out firmly like a switchblade knife, and never accidentally retracts once out. It is available in 16GB, 32GB, and 64GB capacities and includes encryption software that lets you drag-and-drop files into a hidden, password-protected portion of the drive represented by a vault icon that sits on your desktop. It's slick but we could never tell how much space it was taking up, as it's a "hidden" volume, so it'd be nice to be able to allocate a certain amount of storage for it.

In our testing, the SanDisk was the slowest in synthetic read speeds by a decent margin, but second-fastest in write speeds. In file-copying, it was second-fastest in the 10GB test, and third-fastest in our 30GB write test, but by a very small margin.

On balance, the SanDisk is a well-designed key that is extremely affordable. It would have become our all-time favorite if it were just a bit faster.

VERDICT 9
SanDisk Extreme USB 3.0 64GB
$72 (street), www.sandisk.com

BENCHMARKS

	Lexar P10 USB 3.0 64GB	LaCie RuggedKey 64GB	Corsair Flash Voyager GS 64GB	SanDisk Extreme USB 3.0 64GB
Price	$120	$100	$80	$72
30GB Photo Transfer (sec)	243	394	**231**	254
10GB MP3 Write (sec)	**94**	147	155	95
AS SSD				
Seq. Read (MB/s)	250	204	**268**	186
AS SSD Seq. Write7 (MB/s)	**202**	134	168	178
CrystalDiskMark				
Avg. Read (MB/s)	265	216	**296**	202
Avg. Write (MB/s)	**239**	123	193	194

Best scores are bolded. All tests conducted on our hard-drive test bench, which consists of a Gigabyte Z77X-UP4 motherboard, Intel Core i5-3470 3.2GHz CPU, 8GB of RAM, Intel 520 series SSD, and a Cool Master 450W power supply.



The fan cables are short, but the bundled Y adapter gives them plenty of total length.

Silverstone Tundra TD03

A promising first step

EVER SINCE closed-loop liquid coolers (CLCs) arrived on the scene, hardware manufacturers have been scrambling to get a slice of the pie. On paper, CLCs can achieve better performance than even the most expensive air coolers, and more quietly. Because PC technology is always evolving, it's rare to see a genuinely new and interesting war front appear—if you're not participating in it, you might get left behind. Silverstone has stepped into the game with its Tundra series of CLCs. Last month, we reviewed its 240mm TD02, and now it's time for the TD03, which is the 120mm version.

At a glance, the TD03 is similar to the Corsair H80i. The 120mm radiator is paired with two 120mm fans that install in a push-pull orientation, where one fan pushes air into the rad on one side, and the other fan pulls it out. You can reverse the direction, but the temperature difference is usually negligible.

The TD03 has a very different look, however. Its tubes are enclosed in white corrugated plastic, the rad's housing is white, and the water block installed on top of the CPU is housed in brushed aluminum. If we were scoring purely on aesthetics, the Tundra cooler would walk away with a gold medal.

The rad is also nearly twice as thick as usual (with about twice the fin density, as well); combined with the two fans, you need a whopping 3.75 inches of clearance. Unless you have a cavernous super-tower (our test case is a Corsair 900D), the TD03 is not fitting in the top of your case. It will go in the rear, but high-profile RAM on an LGA2011 motherboard may obstruct it. You may have a 120mm fan mount in the bottom of your case, but a radiator's reservoirs need an inch or two of extra space on each side, so it's not guaranteed to work. And the tubes might not reach.

On the bright side, installation for Intel CPUs is made easier with two pre-installed aluminum brackets, and a generally minimized number of widgets. The LGA2011 socket needs only four easily distinguishable bolts, and a set of four screws with springs on them. And the Intel bracket is attached with four screws, so it's an easy swap to AMD. Since aluminum dissipates heat better than the standard plastic housing and is more impact-resistant, it's a good choice for protecting a copper block, albeit a relatively expensive one. That and the extra materials in the jumbo-size radiator put the TD03 in a different price range than a standard 120mm CLC.

So, the 64-gigabyte question is, does the TD03 have the performance to justify its premium design? Not as much as we'd like, unfortunately. We tried both airflow directions, different amounts of thermal paste, and even laying the case on its side. But in the end, the TD03 came in a half-step behind the competition in its price range. At around $100 on the street, it's up against the likes of the Corsair H100i and the NZXT Kraken X60, which consistently outperform it, if slightly. Are the TD03's fins too densely packed for its fans? Are the liquid tubes too narrow? We'll leave it to the science wizards to figure that out. But until then, we can't quite recommend this cooler over others in its class.

–TOM MCNAMARA

VERDICT 8

Silverstone Tundra TD03

+ BIRDMAN OF ALCATRAZ High-quality materials; easy installation; stand-out appearance.

– ALCATRAZ Underwhelming size-performance ratio; relatively noisy.

$100, www.silverstonetek.com

BENCHMARKS

	Tundra TD03 Quiet / Performance Mode	Kraken X60 Quiet / Performance Mode	H100i Quiet / Performance Mode	212 Evo Quiet / Performance Mode
Ambient Air	20.7 / 21	20.9 / 20.7	20.3 / 20.5	20.5 / 20
Idle Temperature	30 / 29.2	**29.67 / 28.8**	30.7 / 29.3	35.5 / 30.5
Load Temperature	68.8 / 65	**66** / 61.8	67.1 / **61**	70 / 67.3
Load - Ambient	48.1 / 44	**45.1** / 41.1	46.8 / **40.5**	49.5 / 47.3

Best scores bolded. All temperatures in degrees Celsius. All tests performed with an Intel Core i7-3960X at 4.1GHz, on an Asus Rampage IV Extreme motherboard, in a Corsair 900D with stock fans set to Standard.

SPECIFICATIONS

Radiator Dimensions (H x D x W)	1.77 x 6.26 x 4.88 inches
Weight	3.1 lbs
Stock Fans	2x 12cm PWM
Socket Support	LGA1150/1155/1156/1366/2011; AM2/AM2+/AM3/AM3+/FM1/FM2
Additional Fan Support	No



Phanteks goes to great lengths to help you conceal cables, but its water-cooling apparatuses get in the way a bit.



Give up your gym membership; lifting this case up and down is all the workout you'll ever need.

Phanteks Enthoo Primo

A big, monster case with a few little quirks

WE APPRECIATE it when a case manufacturer dares to go above and beyond the standard construction techniques we see time and time again. Enter Phanteks's Enthoo Primo chassis—a case that sounds more like a sneeze than a container for your expensive hardware, but one that comes with a few tricks hidden within its jet-black frame. However, a few peculiar quirks make us hesitant to give this $250 chassis a full-on recommendation.

To begin with, we were annoyed with the Primo's packaging. Not that the box it arrived in didn't adequately protect the near-40-pound steel chassis with the help of a ton of foam, but rather that Phanteks covered the case with protective wrap that was stickier and gooier and more difficult to take off than what we're used to dealing with. And there's quite a lot of it, too.

Moving on to the case itself, the Primo's five 5.25-inch bays are screwless and easy to access by popping off the grilled covers on its front. We just wish we could switch the case's front-panel door from swinging open right-to-left to left-to-right—like on a refrigerator. The Primo's six drive bays all use easy-to-install trays to hold your storage in place, and the case itself comes with two areas on the rear of the motherboard tray where you can double-stack SSDs (so, four total).

Slapping an ATX, eATX, or mATX motherboard into this case is pretty easy, given its pre-installed standoffs. Swapping an aftermarket cooler into a build is similarly simple, thanks to the huge, cut-out hole on the upper half of the motherboard tray.

Installing a standard video card into the Primo is a bit trickier since a large reservoir bracket covers the right half of the motherboard area. We didn't have any room whatsoever to slap a 10.5-inch GTX 480 in the case as-is; we had to first remove the bracket's cover and, even then, it was an extremely tight fit. Video cards measuring 11 inches or more need not apply. Yes, you can remove the bracket entirely, but it's just one more somewhat annoying step in the installation process.

The reservoir bracket, when in place, severely hampers one's ability to effectively manage cables within the case. But even with a standard ATX motherboard installed, two of the case's seven rubberized cable mounting holes on the tray itself are ever-so-slightly covered up; it's not a deal-breaker, but mildly annoying given the sheer size of the full-tower chassis.

The case's connectivity is pretty standard: two USB 2.0 ports and two USB 3.0 ports on top. The connectors themselves are covered by lovely rubber tabs, but these tabs aren't themselves attached to the case in any fashion—making them neat to look at but super easy to lose. An additional button controls the case's lovely lighting, a thin blue strip that runs over the front-right side and up onto the case's top.

What we'd love to see on this case is a fan controller. A built-in circuit board allows you to connect up to 11 different fans to a single, 4-pin connector—presumably, you'd be able to control everything via your motherboard. We think a dial, switch, or some other means of changing up your fan speeds on-the-fly would be a lot easier.

The Primo is an odd hybrid. It comes with plenty of cooling, support for plenty of devices (including *two* PSUs, if you dare), and offers a lot on the liquid-cooling front. However, its ease-of-use is countered by a few nagging features that, for a case this costly, should have been eliminated at the drawing board. For this much scratch, you could almost snag a 10/Kick Ass–winning Corsair Obsidian 800D. –**DAVID MURPHY**

VERDICT 7

Phanteks Enthoo Primo

+ PRIMARCH Installing drives and 5.25-inch components is a breeze; excellent cable management (minus two routing holes); absurd water-cooling support; lovely aesthetics.

− GETH PRIME Tight fit on the inside unless you start unscrewing things; fan hub should be a controller; case weighs a ton; space feels a bit wasted for the 99 percent not using dual PSUs.

$250, www.phanteks.com

Google and Asus again teamed up to make the new Nexus 7, and while the physical changes are subtle, they amount to a more sophisticated-looking device.



Google Nexus 7

Same name, new-and-improved experience

IT'S HARD NOT to have high expectations of Google's new Nexus 7—the original was a standout product that offered a satisfying Android experience in a highly portable 7-inch form factor, for less than $200. Now we've got the new Nexus 7 (is it us, or is it very annoying that it has the exact same name?) promising a number of refinements to the original, but also asking a higher price: $230 for 16GB, $270 for 32GB (reviewed here). You're probably wondering if it's still a compelling product.

Like the first Nexus 7, this one was built for Google by Asus. As you'd expect from a tablet refresh, the new Nexus 7 is lighter than its older sib, down from 12 ounces to 10.22 ounces; it's also narrower by about a quarter-inch, and ever-so-slightly thinner. The new dimensions make this Nexus 7 even easier to hold with one hand, and more notably, transportable in a pants pocket. Seriously. That is, if the pants aren't too snug.

The 7.87x4.49x0.34-inch body frames a 7.02-inch, 1920x1080 IPS screen (up from the OG's 1200x800), which offers 323ppi and a damned fine picture. The 16:10 aspect ratio seems a little long and thin at first (especially compared to an iPad mini's 4:3), but ultimately it didn't detract from our enjoyment of movies, apps, and books—all of which looked clear and vibrant on the device. Other welcome modifications include three speaker grills—two on the lower back of the device, one on the upper back—versus the single speaker on the back of the original. In other words, noticeably improved sound over the earlier version's mono audio. The 2.0 device also adds a 5MP back-facing camera. The social acceptability of using a tablet as a camera notwithstanding, the Nexus 7 snaps pretty nice pics if the lighting isn't too low (grainy) or too bright (washed out); it also sports autofocus and can shoot 1080p video. The 1.2MP front-facing camera from the original remains, although it's been shifted to the right of center over the screen. The headphone jack has been moved from the bottom of the device to the top.

Of course, the Nexus 7's guts have also been rejiggered, in ways that we approve of. This time around, the tablet sports a 1.5GHz Qualcomm Snapdragon S4 Pro (with a quad-core CPU and Adreno 320 graphics) and 2GB of RAM, compared to the Tegra 3/1GB RAM combo of yore. Performance in benchmarks was impressive, with the new Nexus outpacing the old by an audacious 200–300 percent in 3DMark. In civilian use, the device showed verve, loading web pages, scrolling, and launching app after app without hitches. Naturally, it runs the latest version of Android, Jelly Bean 4.3, which takes up a full 6GB of storage. There's still no SD card slot for memory expansion, but you can attach an external drive via the microUSB port.

Due to its slightly flatter body, we're guessing, the new Nexus 7's battery got a bit smaller—going from 4,325mAh to 3,950mAh—but we found it could last for as long as two days of regular use between charging, as long as screen brightness wasn't turned all the way up. When we looped a 1080p video for four hours, we were left with 62 percent battery remaining.

Yes, Asus and Google stepped up their game with the new Nexus 7, improving mission-critical features like the screen, sound, size, and performance enough to make its higher price seem reasonable. (And still is costs $100 less than an iPad mini!)

Does anyone really *need* a tablet? Probably not, when we've got phones and laptops that serve overlapping purposes. What makes the Nexus 7 so great is that it fulfills all its duties capably at a price that won't make you feel guilty should the novelty wear off. **–KATHERINE STEVENSON**

VERDICT 9 KICK ASS!

Google Nexus 7

+ DROID Nice screen; stereo speakers; good battery life; improved performance.

− DRUID OS takes up 6GB; no SD slot; power and volume buttons are easily mixed up.

$270 for 32GB w/Wi-Fi, www.google.com

SPECIFICATIONS

OS	Android Jelly Bean 4.3
Processor	1.5GHz Qualcomm Snapdragon S4 Pro
Memory	2GB
Screen	7.02-inch, 1920x1200 (323ppi), IPS
Storage	16GB, 32GB
Cameras	5MP rear (1080p video), 1.2MP front
Connectivity	IEEE 802.11b/g/n, optional 4G LTE, NFC, Bluetooth 4.0, microUSB, 3.5mm audio, mic
Weight	.64 pounds (Wi-Fi only); .66 pounds (LTE option)
Dimensions (H x W x D)	7.87 x 4.49 x 0.34 inches



While we're big fans of "starving them out," you can also employ fun rock-chuckers to encourage enemies to vacate a city.

Total War: Rome II

We hope you have some chores to do between turns

IT DIDN'T TAKE LONG, but we soon came to a point within our Total War: Rome II empire-building where it would have been much nicer to just build a big wall around our smattering of conquered lands, put up a "Go Away" sign or two, and live out the rest of our days in boredom and serenity. After all, the game had already taken us pretty far toward the former.

It's a shame, too. We can recall spending (too much) time playing many of the predecessors in the Total War franchise—moving around armies and special units as if we were playing a hybrid of Risk and chess, and jumping into absurdly fun, sprawling battles reminiscent of the opening scene of *Gladiator*. That's all still present in Total War: Rome II, but the game itself just isn't all that compelling.

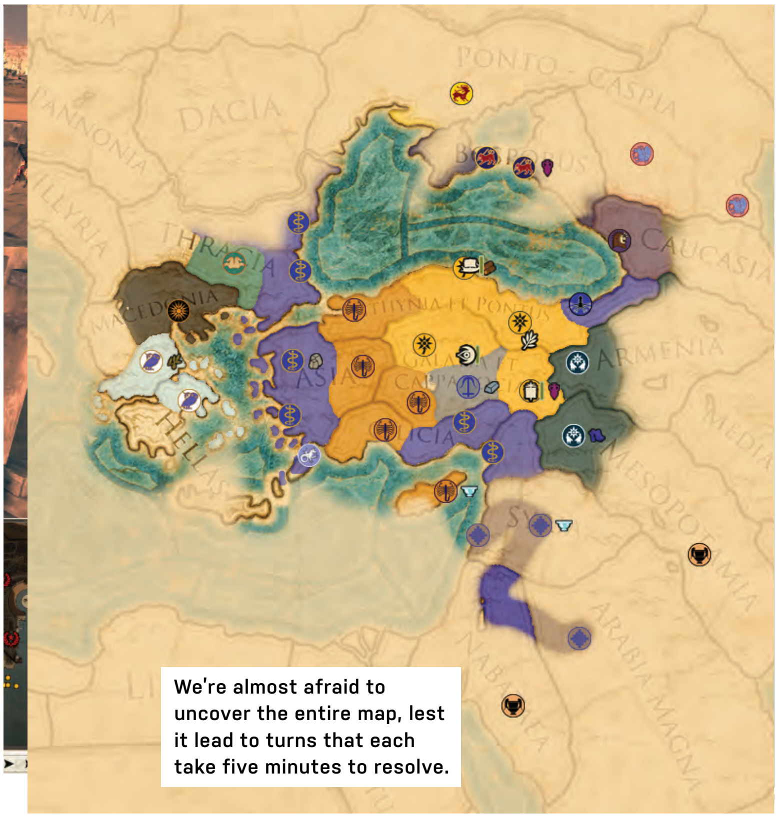
For one thing, it's huge. Starting off any of the offered campaigns (which is the closest you'll get to a "story mode" within this strategy title, save for its "prologue" trainer campaign) presents an overwhelming amount of factions and lands for you to deal with. That doesn't sound so bad at first, given that the game *is* called Total War and you should really arrive expecting to dance with a number of lesser folk. However, just getting through a simple turn or two is a battle unto itself.

We were rocking a fairly beefy system to play this title—even going so far as to install the game on an SSD—and we still found ourselves waiting around 45 seconds or so just to get through the turns of our campaign's many, many other players. Worse, that was just in our campaign's early game when not all that much is happening around the map. Best of luck to you if your computer is a little slow on the uptake; you might want to go make a sandwich (or mow the lawn) while the AI does its thing.

If you like to turtle—sitting inside your borders and building a lovely little civilization while everything else around you burns—this might not be the title for you. There's simply not that much to do within the game's city-building component, save for carefully managing the balance between your provinces' public order and food. Want to make a building that gives you more food? More unrest! Want to quell the unrest so you can make more food or other buildings that confused us as to their usefulness? Insert random building here!

There's also a growth-rate mechanic that allows you to increase the size of your cities, assuming you're even allowed to add more buildings—some will be limited to just a few. In other words, Total War: Rome II ain't Civilization; don't expect to be able to take every city of yours through some kind of masterwork plan to transform it *into* the next Rome; expect to do a lot of minutia calculating as to whether your simple upgrades will make or break your faction's food surplus (or start a decrease in public order). Spoiler: You really don't want to break your provinces' careful balance.

Unless you have armies on the move, the city/cultural aspects of the game contribute to its boredom, thanks to the aforementioned overabundance-of-factions issue. If you find yourself with a few turns where you're just taking care of business at home instead



We're almost afraid to uncover the entire map, lest it lead to turns that each take five minutes to resolve.



It's no *Saving Private Ryan*, but sailing toward a garrisoned city (full of painful archers) does feel a bit awe-inspiring.

of marching around and sticking pointy spears through everybody, you might very well be waiting five minutes for the 20 seconds' worth of action that you've taken. Do this enough, and you'll turn yourself into a warlord if for no other reason than to give yourself a bit more to do.

Similar to previous Total War titles, there's a whole micromanagement aspect behind your faction's "characters"—your generals, thieves, nobles, and other "special" units. As they grow, you can assign them skills and upgrade their abilities and statistics. You can marry them off, promote them, kill their wives, and even attempt to kill them off, depending on how their growing influence factors into your faction's politics. If that sounds confusing, if not antithetical, don't worry; we didn't have much of a clue what we were doing in this element of the game, nor is it quite clear what you *should* be doing on the political field (nor is this level of micromanagement all that much fun).

We partially blame the game's "throw you into it" mentality. Admittedly, Total War: Rome II does come with a lovely "prologue" campaign that's designed to get newbies up to speed on the game's various parts; we recommend you not skip that, even if you're a fairly accomplished Total War player (and will no doubt find yourself unchallenged in the campaign's actual battles). At the end of the day, however, there's just a lot going on within Total War's "map mode," for lack of a better way to phrase it, and it's not exactly thrilling work.

That brings us to the battles.

We greatly enjoy the raw, physical fighting of the Total War series, and Total War: Rome II spares no expense in that regard. While the computer still remains fairly out-thinkable, there's just a delightful joy that comes each time you fire up your cavalry's special abilities and run them right through enemy archers—and that's just the beginning.

Total War: Rome II ups the ante by throwing naval combat into the mix, and it's every bit as beautiful as it is tactically interesting (even though we wish there were a way to move one's troops from land to ships, and vice versa, within the general campaign). You'll smile with delight the first time you zoom in to watch your troops leaping over from your ship to an enemy vessel; disembarking a huge chunk of whoop-ass in front of a garrisoned city within a battle is even more glee-inducing.

However, Total War: Rome II's prettiness comes with a price. We didn't quite expect to see frame-rate issues, thanks to our system's Nvidia GTX Titan card, but our battles definitely got choppy when we cranked the game to its highest graphical settings. The developer has since patched the game, but after our deadline had passed. Bummer.

Total War: Rome II puts us in the precarious position to say that the game's a half-success: The rock 'em, sock 'em battles are fun and engaging (albeit imperfect), but the game's larger strategy elements make us want to retreat back to the pleasantry of Civilization V. Unless you want to throw down every turn you get (which you might very well do, should you opt to enslave your beaten foes), Total War: Rome II is a tough, strategic slog to get through. –DAVID MURPHY

VERDICT 6

Total War: Rome II

+ TOTAL ANNIHILATION Gorgeous battles and strategic map visuals; naval combat; built-in Wikipedia-like help system; compelling tactical elements within general combat.

− TOTAL CEREAL Too many factions; turns take forever; micromanagement abounds; city-building lacks depth; army-building lacks urgency; graphical hog.

$60, www.totalwar.com, ESRB: T

LAB NOTES

GORDON MAH UNG **DEPUTY EDITOR**



Mobile Benchmark Woes

Mobile performance tests still stuck in the '90s

ONE THING I'VE SAID for a long time (and now product vendors are starting to agree, finally) is that mobile benchmarks kind of suck. It's very much like the PC benchmarking scene in the 1990s. Back then, vendors "optimized" for synthetic tests, which actually hurt performance in actual games. It's an opinion that's gaining traction. Before I got to play with Intel's Bay Trail Atom chip, the press was reminded that a lot of benchmarks can't be trusted, with some memory and CPU benchmarks not actually testing RAM or the CPU at all.

I have to note that Intel itself faced questionable-benchmarking allegations recently, too, but that's too much story for this column. The upshot is that mobile-hardware benchmarking is as immature as the platform itself. So, remember to take most mobile benchmark results with a grain of salt.





Katherine Stevenson
Editor-in-Chief

Given that this month is our Technology Preview, it seems appropriate to talk about a new screen technology that we're likely to start seeing in the year ahead: IGZO-TFT. Dell is using it in its upcoming XPS 15 laptop. Short for indium gallium zinc oxide, IGZO reportedly offers image quality that rivals IPS panels while costing less.



Jimmy Thang
Online Managing Editor

I had the opportunity to check out Google Fiber in Kansas City, MO this month. With speeds up to a 1GB/s, the service was blazing fast. Hopefully it will make its way to my neck of the woods soon. Hell, coupled with Google Drive cloud storage, maybe Chromebooks will finally be a viable PC option.



Josh Norem
Senior Editor

It's the calm before the storm in the Lab, as AMD is gearing up to release its second wave of GCN video cards, and Nvidia is preparing its all-new Maxwell cards for battle in 2014. This round promises to be Nvidia's GK110 going up against AMD's new Hawaii GPU, and I can't wait to see the battle unfold.



Tom McNamara
Associate Editor

With four gaming laptops in the office and an Iris Pro-based unit, we kind of had a cross-section of an entire market segment. AMD is about to unleash a new gen of video cards. And two new consoles loom in the distance—based on x86 tech this time. It feels like we're riding a wave from one era to another.

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> GPU Testing
> G.Skill RAM
> State of PC Audio

Margin Call

How do you account for the margin of error in the performance of a computer part? For example, if the new Nvidia GTX 780 made by company A is 2 percent faster than the Nvidia GTX 780 made by company B, then you can't really say that the one is better than the other because the results may be due to something other than the video card itself if it's that small of a difference. What measurements do you guys have in place to make sure that the difference in performance between two components are due to the parts themselves and not due to something like a hiccup in the power current, or even a SATA cable that is a tiny bit faster than an identical cable?

—Patrick McGuirk

SENIOR EDITOR JOSH NOREM RESPONDS: There will always be small discrepancies between benchmark runs for video cards due to the nature of the benchmarks themselves, variances in power delivery to the card, cooling differences, and so on. To make sure the numbers are reliable, we run all our tests on the exact same system that has been in place for over a year and a half now, so there are no other variables to consider. We also run each test multiple times to make sure there are no anomalies being reported. It's also important to note that our scores may differ from your scores, as no two GPUs are exactly the same, and performance of the same GPU from two different manufacturers might be very close, so the difference really comes down to warranty, software, and overclocking ability.

Using Win8 Upgrade for a Thumb Drive

In the September issue you have a very interesting explanation of how to create a Windows 8 thumb drive ("The Ultimate Thumb Drive Toolkit"). I see it as a perfect method to test Win8 without having to actually install it (shudder).

However, your process supposes a Win8 installation disc, or ISO. I bought the Win8 upgrade for $39 back in January. How would I go about creating the Win8 thumb drive? Would it work to install Win7 to the drive, according to your guide, and then install the upgrade over it? If only Win8 has the capacity to run from a thumb drive, this may not be possible.

I'm sure I am not the only owner of the upgrade who would like to use your guide to try out the OS without danger.

—Pierre Corbeil

CONTRIBUTING WRITER MARCO CHIAPPETTA RESPONDS: The short answer is, there should be no difference in the process at all. Because the install.wim file is manually extracted from the disc (or ISO) and is decompressed and installed to the flash drive manually using imagex, and not the Windows installer, the upgrade checks will be bypassed.

As long as the disc/ISO is similar to the one provided by the MS download, it should be fine. I tried the upgrade edition and it worked.

G.Skill Not in the House?

G.Skill memory is extremely popular. How come *Maximum PC* is silent on the brand in reviews and builds? Is something wrong with it?

—Chris Ajemian

DEPUTY EDITOR GORDON MAH UNG RESPONDS: Chris, the honest truth is that G.Skill was originally my nerdcore rap name (actual birth name Cassius Alowishus Wetzl), but due to the infamous City of Industry-Santa Clara rivalry, I long ago hung up my Neumanns in favor of preaching nonviolent PC building and have taken a stand against the glorification of RAM overclocking.

Seriously, though, we have used G.Skill RAM in previous builds, it's just been a long time. G.Skill is perfectly fine. We generally don't review RAM, as it's mostly a commodity component today. We do, however, recommend that people buy from reputable and well-known vendors, such as G.Skill or the others you usually hear about, rather than no-name, off-brand companies.

I Thought RAID Had an Ad-Vantage

In your test of SSD RAID vs. single SSD ("Put It to the Test," October 2013), what version of Intel's Rapid Storage Technology did you use? I'd like to know if Trim was used with RAID 0 in your test.

submit your questions to: comments@maximumpc.com

Perhaps the lack of Trim explains why the single drive was 3x faster in PCMark Vantage than the two drives in RAID 0.

—Mark

SENIOR EDITOR JOSH NOREM RESPONDS: Version 11 or higher of Intel's Rapid Storage Technology software can pass the Trim command to RAID arrays, and we ran version 11.6.0.1030 for our tests, so it should have been functioning. The problem with the Trim command is that there's no way to tell from a user's point of view when it's running, or whether it has ever run. You should be able to get around this perplexing scenario by manually running Trim in Windows 8—we have not tested that specific setup, but it should work. To your point, our best explanation for the RAID array's performance in PCMark Vantage is that the benchmark doesn't scale well with multiple drives, which happens in some consumer-level workload scenarios. Also, if we had been using an older version of the software that didn't support Trim, it's possible that the drives' built-in garbage collection routines would have been able to keep the drives optimized.

> "SELECTING WINDOWS 8 SEEMS MORE LIKE A NIGHTMARE THAN A DREAM

Are You Deaf?

Every year I look forward to reading the specs and benchmarks of the Dream Machine. This year, I have to admit some skepticism. Yes, the beige issue was addressed in the article, but I still dissent from that opinion. Also, selecting Windows 8 seems more like a nightmare than a dream. Perhaps most irritating is the blatant oversight in audio; no discrete sound card and zero speakers. Not exactly a stellar gaming or audio/video machine, now is it? As a side note, I consider the Creative Fatal1ty Pro card and Klipsch ProMedia v2 400 speakers some of the best hardware in my setup.

—Tom Rand

DEPUTY EDITOR GORDON MAH UNG RESPONDS: Tom, I know you're disappointed, and no one's more disappointed than me—with the current state of PC gaming audio. The golden age of special APIs that developers actually use and full 5.1 analog speakers with wires running everywhere are unfortunately behind us. The vast majority of gamers today use headsets. Even worse, those headsets are mostly USB, so they just bypass the fancy discrete sound card.

[NOW ONLINE]

FIX MOBILE BENCHMARKS NOW!

Tablet and phone benchmarks, in a word, stink. At least that's the guidance from Intel engineers, who say the mobile benchmarking scene resembles the early days of PC testing, when bad benchmarks and outright cheating were prevalent. Read Deputy Editor Gordon Mah Ung's analysis of the current crisis and what's needed to make mobile tests more meaningful. http://bit.ly/mpcintel



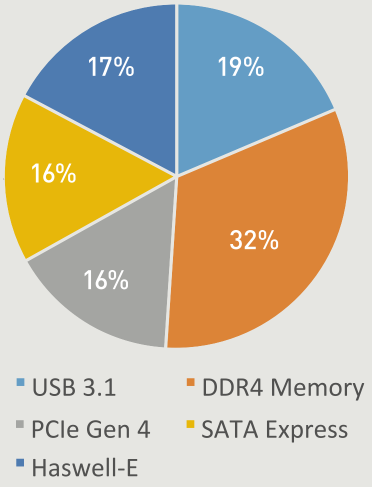
Facebook Polls

What Would You Do with a Dream Machine?

We've received a lot of requests to enlist the Dream Machine in various tours of duty ranging from folding to bitcoin mining. This prompted us to ask our Facebook fans what they would do with the world's most powerful computer.

Evan Beck: Minesweeper on Extreme settings.
Bruce Dodson: Two gifs at the same time, man.
Sterling Bonzo: HD porn across four monitors.
Will Young: Hack the Gibson.
Paul Stringer: Figure out "woman."
James Angell: Thermonuclear war.
Mike Roman: See how it runs Crysis.
Yi Long: Watch cat videos.
Jason Rasmussen: Run Adobe Flash without a hiccup.
Alex Cutadean: Help cure diseases, and a little Crysis.
Jonathan Vazquez Duran: Let it become self-aware.
James Knight Julian: Go on Facebook and comment on stuff.
James Gaddy: I'd turn my basement into a command center.
John Wohlgemuth: Put the specs in my sig and post it everywhere.
Nick Fealey: Play GTA V! Oh, wait....

What 2014 Tech Are You Looking Forward to the Most?



Like our page at www.facebook.com/maximumpc

THE BUILDS

BUDGET



INGREDIENTS

PART			PRICE
Case	NZXT Source 210 Elite		$43
PSU	Corsair CX500M 500W	NEW	$35
Mobo	Gigabyte GA-B85M-D3H Micro ATX	NEW	$80
CPU	Intel Core i5-4430	NEW	$185
Cooler	Stock Intel cooler		$0
GPU	MSI Radeon HD 7790 R7790-1GD5/OC		$100
RAM	2x 4GB G.Skill Ripjaws DDR3/1600 F3-12800CL9D-8GBRL	NEW	$65
Optical Drive	Samsung SH-224BB		$15
SSD	Kingston HyperX 120GB SSD SH103S3/120G	NEW	$90
HDD	Western Digital Caviar Blue 1TB		$65
OS	Windows 8 64-bit OEM		$87

Approximate Price: $765

INTEL HAS FINALLY released its budget Haswell chips, so we've upgraded our Budget build's Ivy Bridge Core-i5 3350P CPU to the new Core i5-4430. Switching to Haswell also gives us the Z87 chipset, granting us four SATA 6Gb/s ports while the older Intel chipset was limited to two. The Thermaltake PSU we used last month is no longer on sale, so we swapped it with the reliable Corsair CX500M. On the SSD front, we upgraded from the 64GB SanDisk Ultra Plus to the 120GB Kingston HyperX, as the prices for 120GB SSDs are so low now that a sale allowed us to squeeze one in without busting the budget. We also swapped out the RAM because the Crucial Ballistix RAM we had last time went up in price.

BASELINE



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Case	Corsair Carbide 300R		$60
PSU	Corsair CX500M 500W		$35
Mobo	Gigabyte GA-Z87-UD3H		$160
CPU	Intel Core i5-4670K		$240
Cooler	Cooler Master Hyper 212 Evo		$34
GPU	Sapphire Radeon HD 7950 100352-3L	NEW	$200
RAM	2x4GB G.Skill Ripjaws DDR3/1600 F3-12800CL9D-8GBRL	NEW	$65
Optical Drive	Samsung SH-224BB		$15
SSD	Intel 335 Series 240GB	NEW	$169
HDD	Seagate Barracuda 1TB		$70
OS	Windows 8 64-bit OEM		$87

Approximate Price: $1,135

AT THIS TIER, we had already switched to Intel's fourth-generation Haswell CPU last month, so things are quieter on that front than in the Budget tier. We swapped GPUs though, because this model Sapphire HD 7950 is $20 cheaper than the 11196-19-20G model we used last month, but performs the same. We also found a 240GB Intel SSD on sale, allowing us to upgrade from the 120GB Samsung 840 Evo that was in here last month. The bigger SSD caused a $40 bulge in this rig's budget, but we like having the extra space for Steam games. If you can't find the Intel 335 at this price, the 250GB Samsung 840 Evo or Crucial M500 are good alternatives. We swapped the RAM from Corsair Vengeance due to price increases.

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INTEL'S IVY Bridge-E CPUs have finally arrived, allowing us to upgrade from a Sandy Bridge-E Core i7-3820 to a Core i7-4820K. Sure, we could have gone Haswell, but we prefer having the option to upgrade to a six-core CPU down the road, and we also like the extra PCI Express lanes for multi-GPU setups. Plus, the Core i7-4820K's unlocked multiplier makes overclocking easier than with the Core i7-3820, and it's also a faster chip.

On the storage front, we doubled our SSD capacity this month by upgrading from a 256GB Samsung 840 Pro to a 500GB Samsung 840 Evo. Sure, the Pro version is Samsung's top-tier drive, but the Evo is still blazing-fast and more reasonably priced. The 512GB 840 Pro would have cost us another $100 or so, which was difficult to justify.

Otherwise, we are holding steady with the Corsair HX850 PSU and the Asus Sabertooth motherboard since they are both tried-and-true, and totally rock-solid. The Corsair H80i CPU cooler remains a great value at $85, and the NZXT Phantom 530 case is a smokin' deal.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best.

INGREDIENTS

PART		PRICE
Case	NZXT Phantom 530	$130
PSU	Corsair HX850	$150
Mobo	Asus Sabertooth X79	$320
CPU	Intel Core i7-4820K **NEW**	$320
Cooler	Corsair H80i	$85
GPU	EVGA GeForce GTX 780 ACX	$660
RAM	4x 4GB Corsair Vengeance DDR3/1600	$124
Optical Drive	Asus BW-12B1ST	$60
SSD	Samsung 840 Evo 500GB **NEW**	$350
HDD	Seagate Barracuda 3TB	$135
OS	Windows 8 64-bit OEM	$87

Approximate Price: $2,421

UPGRADE OF THE MONTH
SANDISK EXTREME 3.0 64GB USB FLASH DRIVE



USB sticks have never been known for their blistering speed, but there are some new USB 3.0 drives that flat-out haul ass, like this SanDisk Extreme USB 3.0 key. It's fast enough to shame a mechanical hard drive, and easily fits on a keychain.

$75 (street), www.sandisk.com

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